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THE SAHARA IN 1915.

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The exploration of the Sahara has been carried on, mainly by the French, with persistent energy during recent years. At the same time European control, not only of the Sahara itself but of the surrounding regions, is causing many changes in the social and economic conditions of the desert. The moment is therefore opportune for making a survey of the physical features of the desert in the light of the latest investigations, and at the same time for considering the altered conditions of the inhabitants, their changing modes of life, the possibilities of economic development, and means of communication. In dealing with a subject so large many details must necessarily be omitted, but the references given will enable the reader to study the questions more fully.*

The old notion of the Sahara as a boundless waste of shifting sand—a dried-up ocean-bed below the level of the sea—persists in many minds, and is fostered by tourists whose only knowledge of the desert has been gained by a visit to Biskra. This notion owed its rise to very natural causes. Approached from Egypt or the Barbary States, the only directions from

* In the *Encyc. Brit.* (11th edit.) there is a general survey of the Sahara, as known down to 1910, largely from the pen of Mr. E. Heawood. To the list of authorities there given and the books and journals cited in the following pages may be added: A. Knox, 'The Climate of the Continent of Africa' (Cambridge University Press, 1911); Sir H. H. Johnston, "A Survey of the Ethnography of Africa," *J. R. Anthrop. Inst.*, 1913; W. A. Cannon, 'Botanical Features of the Algerian Sahara,' Carnegie Inst., Washington, 1913; Captain Martin, "Reconnaissance de la région sud et ouest de l'Erg Ighidi," *B.S.G. d'Alger* (1913); Max Montbel, "Nos marches Sahariennes," *Quest. Dipl. el Col.*, vol. 37 (1914); Marco Roselli, "Colla collonna Miani. La regione e le vie fra Murzuk e Ghat," *Riv. Coloniale*, 1914; G. Cora, 'Dottor Gherardo Rohlf's viaggio da Tripoli all' oasi di Kufra,' Milan, 1914; E. d'Almonte, "Ensayo de una breve descripción del Sáhara español," *B.R.S.G. Madrid*, 1914 (with separate maps). For the most recent maps consult the monthly lists in the *Journal*.

which it was approached by civilized man until recent times, the Sahara does present almost everywhere a waste of sand, and much of it shifting sand. Moreover, when the Atlantic coast of the Sahara was made known by Portuguese navigators, that too, from Morocco to Dakar, was found to be continuously lined with sand-dunes. It is true that the Moors knew that there was, in the western Sahara, something else than sand, but their knowledge was either forgotten or not shared by the Christian nations, and the earlier of modern travellers in North Africa, using the Sahara merely as a corridor to the Sudan, did little to dispel current notions about the desert. In a phrase still remembered Lord Salisbury as late as 1890 echoed popular belief in describing the Sahara as consisting of "light soil." * Three years later appeared Henri Schirmer's brilliant monograph *Le Sahara*, which gave a summary of all that was then known concerning the desert, already proved to be of very varied relief and to contain mountain ranges and plateaus of enormous extent.

The size of the Sahara is indeed hardly realized. It covers approximately 3,500,000 square miles and is not much inferior in area to the continent of Europe. Though sand extends over probably 700,000 square miles, rocky plateaus and not sand-dunes are the chief characteristics of the desert. If a generalization be attempted, the Sahara may be described as a great tableland scored by the beds of dried-up rivers, diversified by mountains and depressions, and fringed by a deep belt of sand west, north, and east. Southward there is generally an intermediate zone between "the desert and the sown." The higher plateaux and the mountain ranges occupy a central position and extend across the Sahara northwest to south-east. This elevated region is sometimes spoken of as the bridge connecting the Mediterranean lands with Central Africa, the means by which early man spanned the desert. It is hardly a continuous bridge and there is scant evidence of its use as a means of communication in historic times. It had by then probably served its purpose.

The Central Sahara.—The mass of mountains and plateaux of the Central Sahara formed largely of Archean rocks, consists of two distinct systems linked by minor heights, and of a couple of isolated highland regions. The main elevated mass is a great squarish block of plateaux and mountains lying due south of Algeria and Tunisia. The chief sections of this mass are the plateau of Tademayt, the Tasili † Asgar, the Muidir and Ahnet plateaux, and, south of these, the Ahaggar or Hoggar Mountains. The Ahaggar Mountains alone cover an area as large as the Alps, but their highest points are not much over 8000 feet; some are

* Lord Salisbury was speaking, as it were, agriculturally, comparing the Sahara —which he had just acknowledged as in the French sphere—with the rich lands of Nigeria, secured for Britain as the results of the efforts of Sir George Taubman Goldie. French wits amplified Lord Salisbury's phrase into "Light soil in which a Gallic cock can scratch."

† Tasili = a Berber word for a high plateau.

Scale 1:30,000,000 or 1 inch = 473 Stat. Miles
Railways open
proposed
MEDITERRANEAN SEA
Algiers
Tunis
Tangier
Gibraltar
Oran
Constantine
Biskra
Sfax
Shat el Jerid
G. of Gabes
Tripoli
Derna
Benghazi
Cyrenaica
Sollum
Alexandria
Port Said
Suez
Cairo
Bir Fuka
Medinet el Fayum
Siwa
Aujila
Farafra
Dakhla
Kharga
Aswan
Nile
Wadi Halfa
Nubian Desert
Port Sudan
Berber
Atbara
Khartoum
Omdurman
Kordofan
El Obeid
El Fasher
Darfur
ANGLO-EGYPTIAN SUDAN
ABYSSINIA
Bahr el Sobat
Ghazal
Fort Lamy
Lake Chad
Wadai
Abeshe
Ngigmi
Zinder
Damergu
Sokoto
Kano
NIGERIA
Shari
Rahama
GOLD COAST
Freetown
SIERRA LEONE
Baiama
Konakry
Kankan
Kouroussa
Niger
Kayes
Bafulabe
Bathurst
GAMBIA
Dakar
ST. LOUIS
Senegal
Walata
Timbuktu
Tosaie
Gao
Air or Asben
Agades
Bilma
Ain Galakka
Faya
Borku
Wayta
Ennedi
Tibesti
Mts
Gudo
Bardai
Karima
Adrar Iforas
Tuareg
SAHARA
El Juf
Mauritania
Taudenio
Chingetti
Tanezruft
Silet
Ahaggar or Hoggar Mts
Timmo Mts
Ahnet
Tasili Aggar
Ghat
Murzuk
Fezzan
LIBYA
Tademayt
Ft. Flatters (Temassinin)
Hammada el Hamra
Ghadames
Nefusa
Gharian
Yefren
Jebel Nefusa
Adrar Tusidet
Tidikelt
In Salah
Muidir
Igidi Desert
Erg
West Erg
East Erg
El Golea
Wargla
Ghardaia
Tuggurt
El Wed
Ain Sefra
Figig
Colomb Bechar
Tefilelt
Aigli
Sh. Melghir
El Aghuat
Biskra
Constantine
Algiers
Tunis
Tangier
Gibraltar
Oran
Rabat
Casablanca
Fez
Megader
Agadir
Great Atlas
Tell Atlas
Sahara Atlas
ALGERIA
MOROCCO
Canary Is.
W. Draa
C. Bojador
RIO DE ORO (Span.)
Villa Cisneros
Port Etienne
C. Blanco
Oldjil
Kuffra Oasis
Jof
Libyan Desert
EGYPT
RED SEA
Suez
Port Sudan
Nile
Wadi Halfa
Nubian Desert

volcanic. Further south and east, running in a north-west and south-easterly direction, are the Tibesti Mountains. The Tasili Asgar which extends eastward as far as Ghat is connected by a low chain, the Timmo range, with the Tibesti Mountains.* The two isolated highland regions mentioned are those of Aïr or Asben † and the Adrar Iforas, respectively south-south-east and south-south-west of the Ahaggar Mountains.

In all this region there is comparatively little sand, the chief dunes lying between Aïr and Tibesti. This sand area contains the oasis of Bilma and is traversed by the caravan route from Tripoli to Lake Chad. There is also an area of sand-dunes between Adrar Iforas and Aïr. A third region of sand—stationary dunes in part fixed by the growth of plants and shrubs—lies between Aïr and Chad, and the north and north-eastern shores of the lake are surrounded by sandhills. But though free from great masses of sand-dunes the Central Sahara is extremely forbidding. The mountains rise from and, save on the north, are bounded by level and almost lifeless tablelands. A French mission in 1912 travelled for thirteen days from the Ahaggar mountains towards Aïr without finding a watering-place. These void regions—with large areas of bare rock—are known as Tanezruft, a Berber word signifying their inhospitable character. They consist of rocks of the Devonian and Carboniferous ages.‡ The rivers, which from the southern versant of the Ahaggar ran south and at a recent geological period joined the lower Niger, are now dry. Somewhat more favourable conditions prevail on the plateaux and mountains on the Aïr highlands. Between the granitic and sandstone hills, are wooded hollows and extensive pasture lands, and though Aïr has no perennial rivers the watercourses are filled during the rainy season (August to October). South of Aïr the borderland between the Sahara and the Sudan is now less productive and more desert-like than it was when first visited by Europeans. Though the desert here seems to be encroaching upon the plains of Nigeria, this may be due not so much to natural causes as to the agency of man: political disturbances leading to insecurity and less cultivation and the cutting down of trees, inducing climatic changes.§

None of the other high plateaux and mountains are as fertile as the Aïr highlands, but the ravines which score their sides contain wood and

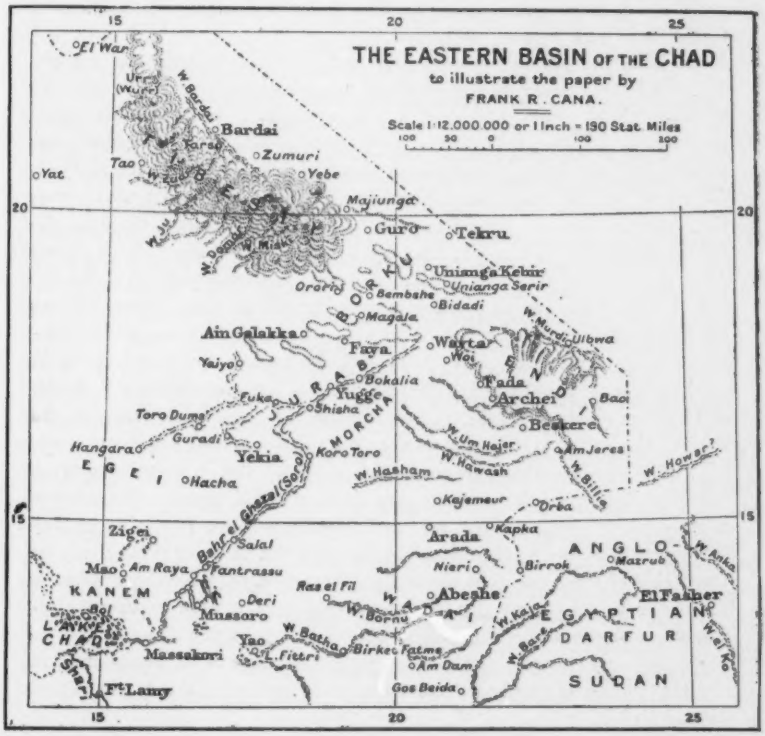
* For Tibesti see *infra*.

† For Aïr see C. Jean's monograph 'Les Touraeg du Sud-Est: L'Aïr,' Paris, 1909, and Captain Nieger in *La Géographie* for 1914. Captain Nieger writes: "South of the valley of the Tesellamen [a wadi which goes west from the Aïr highlands at a point north of Agades] one has quitted the Sahara. The rains are regular."

‡ A description by a recent English traveller of the Tanezruft is given in Captain Hayward's 'Through Timbuktu and Across the Great Sahara.' London: Seeley. 1912.

§ When the Anglo-French boundary between the Niger and Lake Chad was first defined in 1898, it was believed—from the reports of travellers—that the fertile region extended further north than it was found to do. Since that date (1898) the frontier has been taken further south, to give the French a route to the lake in non-desert country.

pasture lands. There are still rivers in the Ahaggar Mountains which contain water for months and even a perennial stream; thus the Ahaggar has sufficient fertility to support several large Berber (Taureg) tribes. At the foot of the mountains, which usually rise from the plain in well-marked escarpments, are found oases of date-palms (*e.g.* Silet) and a fair supply of water. When the railway from Algiers skirts the Ahaggar Mountains there may be an opportunity for development, but



the prospect is not very bright. Muidir and the other plateaux are in no better case than Ahaggar; Tademayt, for example, is very poor in water.

The Algerian and Tunisian Sahara.—The region between the southern slopes of the Atlas range and the mountains and tablelands of the central Sahara contains typical examples of the sand-belts which stretch bow-like across the Sahara and form its northern zone, and also of the most famous of those shats or depressions which gave rise to the idea that that part of the Sahara might be flooded by digging a canal from the Gulf of

Gabes to the nearest depression.* The Shat el Jerid lies temptingly close to the Mediterranean for such an operation, and west of it lies the next largest shat, that of Melghir. The shats are, however, nothing but large, shallow and marshy salt-pans. As to the sand-belts, these are the famous western and eastern Ergs. The eastern Erg reaches almost, but not quite, to the Mediterranean, a steep scarp, the Jebel Nefusa, Gharian, etc., marking here the bounds of the Sahara.† Eastward the Erg is bordered by one of the most desolate districts of the desert, a tableland of red-coloured rock, the Hammada-le-Homra. The Hammada forms the "back blocks" of Tripoli.

It is in the region between and north of the western and eastern Ergs that the French have undertaken considerable irrigation work. It contains shats, oases, and wadis, and supports a comparatively large population. Here are found several towns—Biskra, El Aghuat (Laghuat), and Ain Sefra, close to theA tlas, and Ghardaia, Tuggurt, El Wed, El Golea, and Wargla, further south. All these lead to routes across the desert; that by Ghardaia and El Golea to a passage between the western Erg and Tademayt; that by Tuggurt and Wargla by the Wadi Igharghar (Ir'err'er) direct south. Between Ghardaia and El Golea lies the M'Zab region scored by ravines running east to west. These ravines are filled after storms in the Atlas with torrential streams, which produce abundant verdure. But the sands of the western Erg constantly gain on the plateau, so that the fight to preserve the oases is unending.‡ South of El Golea moving sand-dunes from the Erg are stretching across to the flank of the Tademayt Plateau and have in places reached the escarpment.

The Wadi Igharghar, reached from Tuggurt and Wargla, is a great trough which cuts the eastern Erg into unequal parts. Formerly a mighty river rising in the Ahaggar Mountains and emptying in the Mediterranean, the wadi is now not only dry but is being blotted out by the action of the Erg. It is already obliterated in part, for the problem of fixing the moving dunes by planting desert flora is here apparently insoluble, as the region is waterless. Between Tuggurt and Ahaggar by this route the only (relatively) abundant supply of water is at Témassinin, in the Hanmada-el-Tingerat (a westward continuation of the Hammada el Hofra) and 56 miles east of the Igharghar. At Témassinin, where the French have a post (Fort Flatters), the water is in a deep basin and is useless save for its immediate locality. Artesian borings in this region have failed to find water. The exceedingly difficult nature of this country

* In reality the area which it was proposed to turn into an inland sea covered little more than 3000 square miles—less than half the size of Wales.

† North of the Jebel the coast lands of Tripoli are low and sandy—a little desert with several oases, as is clearly seen on any large-scale map. Eastward of the Jebel the desert-with-oases character of the coast continues. The greater part of Tripoli must be regarded as a semi-fertile region of the Sahara.

‡ For example, Captain Nieger, writing in 1913, recorded that in the M'Zab country, fifteen years after they had been erected the telegraph posts between Ghardaia and El Golea were nearly buried in sand.

has led to the rejection of the proposal to take the trans-Saharan railway by El Aghuat, Ghardaia, and El Golea, and to the rejection also of the more seductive proposal to take it through the Wadi Igharghar.

The main route from Algeria to the Central Sahara is found west of the western Erg. Here, coming from the Atlas, the Wadi Zusfana runs south-west and is joined by the Wadi Gir from Morocco. The combined wadis form the Saura, often after rain in the Atlas an imposing river. The Saura leads to the oases of Gurrara and Tuat and to the broad valley—Tidikelt—which separates Tademayt from Muidir and Ahnet. In Tidikelt is the well-known outpost of In Salah. South from In Salah the Sahara is without towns, until Agades in Aïr—800 miles distant—be reached. Whatever, in favourable conditions, may be done to ameliorate the sandy regions,* the hammada and tanezruft appear irreclaimable.

The Western Sahara: Mauritania.—For at least 2000 years there has been a route across the Sahara from the Niger to Morocco, and there was and is a close connection between the Moors and the Western Sahara. From the Senegal to Agadir, behind the coast dunes, is a belt of uplands rich in pastures and constantly traversed by tribes, Berberized-Arabs and Arabized-Berbers, whose affiliation is with the north; and between the Senegal and the Niger there is a considerable intermediate zone, the Sahel Sudanese. Here Walata, an ancient place, which stands on the border of the Sahara, has been superseded by its younger rival Timbuktu, conveniently situated as the meeting-place of the camel and canoe. The part of the Sahara which lies west of the meridian of Timbuktu, north of the intermediate zone and south of the Moroccan Atlas, contains two very dissimilar kinds of country. The Igidi desert in the north is a continuation of the sand-dune belt, while in the centre is the Juf, unexplored and apparently uninhabited. Though the Juf is probably little else than a waste of sand its exploration should settle some questions of considerable interest to geographers, geologists, and ethnographers. With it should go a detailed examination of the country between the Juf and Tuat. The theory advanced by MM. Gautier and Cortier that the Messaud (which is the lower course of the Saura of Tuat) ran into the Juf, which also received the waters of the upper Niger, remains unproved. The region between Tuat and the Juf has been traversed several times by French military parties since Gautier's and Cortier's books were published in 1908, but nothing appears to have been made known to throw light on this interesting problem.† On the east the Juf is bordered by a sharp line of cliffs and here in the subsidiary depression of Taudeni are the most famous salt-mines of the Sahara. In 1912–13 tribesmen from the Moroccan Sahara raided as far as Taudeni; a party which fled from the

* That is, districts, chiefly old river-valleys, where the soil is good and where water is most abundant. At In Salah, for example, one artesian well yields 880 gallons a minute.

† See on this point the *Journal*, vol. 38, pp. 460, 461.

French into the Juf was never heard of again and is supposed to have perished miserably of thirst.

If the tanezruft and dunes between Tuat and the Juf have been neglected, the region which extends to the Atlantic west and north of the Juf has been explored and even in great part brought under European control. Mauritania, as the French have named that part of the Sahara in their sphere, forms one natural region with the adjoining Spanish protectorate of Rio de Oro, and includes the "belt of uplands rich in pastures" mentioned at the beginning of this section. On the north it links up with the Moroccan Sahara. The description of Mauritania given by Lieut. G. Schmitt in *La Géographie* in 1913 * holds good, but details have since been filled in. The name Adrar, much more common in this than in other parts of the Sahara, gives the clue to the general character of the region, for Adrar is a Berber word for uplands.† It is a great tableland of Archean rocks overlaid by sandstone and cut by many wadis. It contains small wooded regions and areas of cultivation as well as rich pasture lands. Sand-dunes of cruciform shape, rare in other parts of the Sahara, are found here. At Idjil is a well-known salt sebkha from which salt is still exported to Senegal. Though water is—for the Sahara—plentiful, and southern Mauritania supports large herds of cattle, sheep, and goats, there are no permanent streams. Hydrographically, the region consists of closed basins both of ancient and recent date. M. Chudeau ‡ notes that the wadis which descend from Adrar Sotof run inland instead of seaward, and that further south other wadis have cut their way across high ridges. It is difficult to understand why the rivers did not take the easy route to the Atlantic. § M. Chudeau conjectures that the existing contours are recent, which would accord with certain botanical and zoological data, and he concludes that it is probable that the separation of the Canary Islands from the continent does not go back to a remote epoch. The hinterland of the region between Cape Bojador to the Wad Draa is still only sketchily mapped, but it is also tableland (here called gaada), and is probably better provided with pastures than the uplands further south. It is the home of the Reguiebat and Tekna tribes, the great raiders of the Western Sahara. ||

* See the *Journal*, vol. 42, p. 77.

† French writers distinguish the chief *Adrars* thus: those in Mauritania as Adrar Maure; the Adrar of the Iforas as Adrar Nigritien; the Adrar of Tuat as the Adrar Algerien.

‡ *Rens. Col.*, January, 1912.

§ The most southerly wadi—excluding very short coastal streams—to go seaward is the Seguia-al-Hamra (to the south of Cape Juby).

|| Valuable information concerning these tribes and their pastoral riches is furnished by M. P. Marty, who also gives particulars concerning the Walad Delim. The Walad Delim occupy the coast from the Bay of Arguin to the Seguia-al-Hamra. They, or rather a tributary people, the Imraguen, are fishers, and trade with the Europeans and Africans at Port Étienne and Villa Cisneros. Port Étienne, near Cape Blanco, dates from 1908, and is beginning to prosper. It is frequented by Breton

Moroccan Sahara.—The Wad Draa * in its lower course has now, by Franco-Spanish agreement, become the definite southern limit of Morocco, and the Moroccan Sahara is taken to be the country south of the High Atlas from the mouth of the Draa to the Tuat oases. It is little known, but it is a land of promise as it contains three rivers which are never completely dry. These rivers, as they descend from the High Atlas, turn south-west and make for the Atlantic, though of the three only the Draa reaches the sea. The other two are the Ziz and the Gir. The Ziz is economically the most important as it forms the beautiful oasis of Tafilalt, the first resting-place in the desert on the way to Timbuktu from Fez. In it are the ruins of the once famous city of Sijilmessa. The possibilities of cultivation on an extensive scale in the Moroccan Sahara are great if the regulation of the water it receives was carried out. "The flooding of the Saharan wadis . . . is somewhat irregular. The streams, however, in their passage through the Atlas, traverse successive plains and ridges, cutting deep gorges in the latter, and it would appear that the construction of dams to regulate the flood waters would present no unusual difficulty." † The French engineers, now that Morocco is a French protectorate, may be trusted to do what is possible.

The Libyan Desert and Tibesti.—Recent additions to the knowledge of the Eastern Sahara have been made chiefly along its southern border from Lake Chad to Darfur and in the adjacent mountainous zone (Tibesti, Borku, Endi). These additions are of peculiar interest as the work of the last five years has opened up countries almost unknown. The Libyan Desert, which fills so large a part of the Eastern Sahara, remains unexplored. No Europeans, save Rohlfs and his companion, Dr. Anton Stecker, have penetrated into the heart of the desert. Rohlfs' journey was in 1879 and was confined to a direct route from the Mediterranean to Kufra and back. Mr. Oric Bates ‡ and Herr E. Banse § have recently produced monographs dealing with the Libyan Desert, and we are indebted to Mr. W. J. Harding King ‖ for personal exploration and for gathering up such native information concerning the inner desert as is available. The fringe of it which contains the oases parallel to the Nile is fairly well known, ¶ and the impression which this eastern part gives

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fishermen, and since 1912 companies have been formed to deal with the catch. Villa Cisneros is the capital and port of Rio de Oro. There the Spanish officials trade direct with the Imraguen ('Les Tribus de la haute Mauritanie,' *Rens. Col.*, 1915).

* In the Arabic of Morocco wadi becomes wad.

† Mr. Alan Ogilvie in *Geogr. Jour.*, vol. **39**, p. 566. This paper by Mr. Ogilvie gives other information concerning the Moroccan Sahara.

‡ 'The Eastern Libyans' (with map). London (Macmillan), 1914. The information given does not deal with events later than 1911.

§ In *Petermanns Mitteilungen*, March, 1914 (map).

‖ "The Libyan Desert from Native Information," *Geogr. Jour.*, vol. **42**, p. 277.

¶ Consult the geological and topographical reports on the oases issued by the Public Works Dept., Cairo, and for Kharga see also H. G. Beadnell's 'An Egyptian Oasis.' London (Murray), 1909.

seems applicable to other regions of the Libyan Desert. It is a vast plateau partly consisting of bare limestone and rugged sandstone, with crystalline rocks outcropping, but immense areas are covered with sand-dunes, crescent shaped in the north, longitudinal in the east. In the centre are the oases known collectively as Kufra, and a few other oases give a practicable route from Wadai and adjacent regions in the south to Egypt, Cyrenaica, and Tripoli. On the north-west of the desert are the oases of Fezzan and Aujila; on the north-east, towards Egypt, lies Siwa; south-east absolute desert extends to the Nile. On the south-west, towards the Tibesti Mountains and the lower heights of Borku and Endi, there are a number of oases. All these oases, as far as is known, are deep depressions in the plateau, and they derive their water, as far as has been ascertained, from a bed of porous sandstone which underlies a large part of the desert. The Libyan Desert is marked off sharply from the Nile valley by limestone cliffs, and the Libyan Plateau, which extends north of the desert to the Mediterranean, is of limestone formation.

One of the most interesting of the statements made to Mr. Harding King by his native informants was that the dried-up bed of a once great river traverses the centre of the Libyan Desert.* This river-bed is called the Wadi el Fardi, and is said to have been fed by streams rising in the Tibesti Mountains, and to run north by Kufra to Siwa. There, near the southern edge of the Libyan Plateau, it turns east, and, it is to be supposed, reached the Nile somewhere about the head of the Delta. Had this wadi been fed from such inexhaustible reservoirs as supply the Nile we should have seen another Egypt piercing the heart of the Libyan Desert. There has been no such proved change in historic times in the climatic conditions of the Libyan Desert† as would account for the drying up of the wadi, nor is there reason to suppose that the ancient Egyptians knew of another Nile on their western flank. Yet the reality of the Wadi el Fardi is probable. The orography of the Eastern Sahara almost seems to demand its existence.

The thorough exploration of Tibesti may throw light on this problem, but it would need tropical rains to produce water enough to keep alive such a river as the Wadi el Fardi. Since the capture of the Senussi stronghold of Ain Galakka, in Borku, in November, 1913, knowledge of the topography of that region and of Endi (Ennedi) has been completed in its main outlines, and Tibesti has also been visited. The result is that we now know that no large river flows from those mountain regions either towards the Libyan Desert or in any direction. Other interesting

* "The Libyan Desert from Native Information," *Journal*, vol. 42, pp. 277.

† There has been some change in climate in the Eastern Sahara (see *Journal*, vol. 38, p. 464), but in respect to the Egyptian oases and other regions, the increasing desiccation may result from the abandonment of the struggle against nature waged by the ancient Egyptians and the Romans, whose water-conservancy measures the Arabs and Turks neglected.

points have been decided. There is facing the Libyan Desert a continuous escarpment from Tibesti to Endi. General Largeau in his report on the occupation of Borku speaks of his troops marching at the foot of an escarpment about 100 feet high, "prolonging the mountains of Tibesti to their junction with those of Ennedi."* Writing of Borku Captain Ferrandi, who took part in the expedition, tells of a wind-eroded rocky backbone separating series of oases. On the plateau leading from Faya to Guro,† an oasis south of the eastern slopes of Tibesti, "the vegetation at the water-holes fights with tenacity against the sand, but it has to do with an adversary which knows neither fatigue nor repose"—an adversary which had, when Captain Ferrandi passed, already half buried all the trees. Desert conditions are not so severe in Endi as in Borku. Endi is described as a plateau of soft sandstone subject to extremely powerful erosion by wind and water. Besides fantastically fashioned rocks and stretches of sand there are numerous fertile valleys—valleys carved out of the plateau by rivers which after the winter rains carry a good deal of water. Some of these rivers flow for over 100 miles. In the rainy season large lagoons are formed in their clayey reaches. Alligators and moufflon are unexpected examples of the fauna of the country. Though Endi be itself a land of comparative plenty the streams which come down the northern side of the plateau (the chief of these are called Murdo and Nicaulé) end almost at the base of the mountains.‡ Yet northward as far as 20° N. there are numbers of scattered oases, some thorn scrub, and scanty pasturages sufficient to maintain a nomad population. This is the home of the Bedayet—a tribe classed as Sudanese, but probably of Berber-negro origin.

There is only a small area of fertility in the Tibesti mountains. Commandant Lofler, in his expedition to Tibesti in 1913–14, covered much the same ground as that covered by Nachtigal—his only European predecessor in that country—in 1869. That the two routes so nearly coincided had this advantage: it was possible to ascertain what alterations had taken place in the intervening forty-four years. Nachtigal drew a pleasing picture of the fertility of the Zuar valley (on the western side of the Tibesti massif). Commandant Lofler, who reached Zuar in December, 1913, found that the district had greatly altered. Rains had failed and everywhere was seen a picture of aridity. The tamarisks, palms, and, more rarely, thorns which marked the course of the river had been stripped of all foliage, save in their higher branches, by the animals which could not find sufficient herbage for their needs. The people were poor and few in numbers. Cultivation had not ceased, wheat, maize, and tobacco being raised in small patches in the ravines. Small lakes

* *Rens. Col.*, June, 1914, p. 315.

† At Guro is the kubba of Senussi el Mahdi, who died in 1902. It is a large white rectangular building.

‡ "L'occupatin du Borkou et de L'Ennedi," *Rens. Col.*, December, 1914.

containing fish were found in these ravines. The main impression of this the north-western part of Tibesti was of a dying land. Early in 1914 Commandant Lofler received orders to occupy Bardaï, the chief settlement in Tibesti. He crossed the mountains with his convoy of 600 camels by a route north of and lower than that taken by Nachtigal. Lofler went by Urr (Warr), 4600 feet; Nachtigal by Tarso, 7200 feet.

Lofler occupied Bardaï in July, 1914, the Tibbu chieftain who had opposed the French taking to flight. The Tibbu were either unable or unwilling to get a force together strong enough to oppose the unbelievers. Bardaï is an oasis in a wadi of the same name which runs north-west and south-east at the base of the mountains. The oasis is some 2 miles long; through it flows a ribbon of water. Besides the date-palm it produces cereals and vegetables. Ravines which cut their way through the massif to the wadi Bardaï were also found to have small oases and petty cultivation—nothing more. The anonymous writer in *L'Afrique Française*,* who supplies the scanty particulars of the Lofler expedition, comes to this conclusion: "Tibesti presents itself as a massif of entirely denuded rock, life being concentrated in the depth of the ravines near the water." Captain Ferrandi, who had opportunities of gaining information at Guro, but did not himself enter Tibesti, says that between Bardaï and Guro are the valleys of Osa, Zumuri, and Yebé. These, with Bardaï, form "the rich and peopled region of Tibesti," all else being sterile. We await the result of the further exploration of the country. Some traveller may find a dry wadi which, if followed, will lead on to the (equally dry) Wadi el Fardi.

Lake Chad and the Bahr el Ghazel.—From Lake Chad to Endi the zone between the Sudan and the Sahara (now a French possession) is becoming more arid. This zone, much of it level plain, is scored by the bed of the Bahr el Ghazal (Soro) † of the Chad system. The problems connected with this bahr have not yet been solved. Captain Vignon, in 1911–12, traced its course as far east as a depression, Wayta, leading to the plain between the hills of Borku and Endi.‡ According to native reports the Ghazal, avoiding the hills of Endi, goes on eastward, and contains in its unexplored (as in its explored) parts good watering-places, cultivated areas and pastures. Captain Vignon had not the means of taking accurately the levels of the bed of the Ghazal, but he believes that the slope is eastward. The wadis which join the Ghazal west of Borku have also an eastern slope. The theory that the bahr was a tributary of Lake Chad rising in the Tibesti Mountains is discredited; but that does not tell us what the Ghazal is. Its bed has yet to be traced to its end (or beginning) and its levels have to be

* For August–December, 1914.

† This Bahr el Ghazal must not be confused with the Ghazal river of the Nile system.

‡ "Le Réseau Hydrographique der Pays Bas du Tchad," *Rens. Col.*, April, 1914.

ascertained. Those who have seen in the bahr a possible explanation of the mediæval stories of a Niger-Nile connection may be tempted (probably without justification) to make the Ghazal run from Wayta to join the Wadi Hower, a wadi which, according to native reports, reaches the Nile near Dongola. As Mr. Harding King points out, the very existence of the Wadi Hower is doubtful.

Captain Tilho has shown * that from Lake Chad eastward to Fantrassu the Bahr el Ghazal channel is a simple prolongation of the lake. The surrounding country is flat. Chad was at one time a much larger lake than it is now; † as it contracted it may well have developed a system of backwaters and river-like arms such as now mark the Nile in its course between Victoria and Albert Nyanzas. Of this contraction the Bahr el Ghazal may be a witness; its western part marking, as Captain Tilho suggests, an arm of the lake, its eastern part being a true river-bed whether effluent or affluent.

It will be seen that the chief remaining problems of Saharan topography are concerned with its former river-systems. The existence of so many dried up water-channels of large size is conclusive as to an abundance of water in the Sahara at some period, and in the case of the Bahr el Ghazal at least the drying up is "recent." ‡ Without entering into the question as to whether there have been over the desert as a whole marked climatic changes § in the past two thousand years, it is certain that the Sahara fulfils nearly all the conditions stated by Prof. Gregory in his paper contributed to the discussion on deserts at the British Association meeting in Melbourne in August, 1914: "Deserts are most easily produced and least curable where the rainfall is low, the temperature is high, the wind is strong, and the country consists of a plateau where there is an easy drainage to the adjacent lowlands." It is with regard to drainage that perplexities exist. Part of the Central Sahara drained to the Gulf of Guinea, while the drainage of the Libyan Desert was to the Mediterranean by the Nile Delta; but the Chad is an inland basin where desert conditions are encroaching, and, as we have seen, the Juf is regarded as having been the centre of another closed drainage area. The other

* 'Documents scientifique de la mission Tilho.' Paris, 1910–11. The facts established by the mission are summarized in vol. 2, pp. 601–613.

† Students of African hydrography are aware of the extraordinary changes in the area of the lake since it was first visited by Europeans in 1823. The supposition that it had a large surface of deep water and was comparable to the lakes of East Africa gave rise in the eighties of last century to the "race for Lake Chad" between France, Great Britain, and Germany. It proved to be valueless as a highway. The question as to whether there has been any permanent decrease in its area within the last twenty years is scarcely settled, though for years at a time the northern part has been dry.

‡ See the evidence brought forward by Captain Tilho in *La Géographie*, December, 1913 (*Journal*, vol. 43, p. 441).

§ That particular areas have become, since the beginning of the Christian Era, more arid has already been stated.

conditions named, low rainfall, high temperature, and strong winds, appear to have prevailed against the parts played by Lake Chad and the Juf.

In considering pastoral and agricultural possibilities it must be accepted that as a whole the desert conditions of the Sahara are not curable. The indications which may be given as to the development of the land in favourable areas will, however, best follow some account of the inhabitants of the Sahara, political developments, trade, and means of communication. On all these factors land-industries depend.

Peoples, Politics, and Trade.

The majority of the inhabitants of the Sahara are of the Libyan stock known as Berbers. There is not sufficient evidence to dogmatize with respect to the neolithic race which first peopled the Sahara: the supposition that the Western Sahara was, as late perhaps as the time of the foundation of Carthage, an agricultural land richly watered and a negro domain remains a supposition. The Berbers have been in the Sahara as far back as can be traced definitely. In the south they have mixed considerably with the negroes. The only other race strongly represented is the Semitic, the result of the Arab conquest of North Africa. In Mauritania and the Sahel Sudanese Berbers and Arabs have largely intermixed and have produced the "Moorish" tribes of the Western Sahara. There is also in these "Moorish" tribes a negro strain derived partly from times when the Walata region was more fertile and was (it is supposed) thickly peopled by Sudanese.* Between the Niger and the Nile, along the intermediate zone, there is a mixture of races in which the dominant Berber or Arab strain is very markedly crossed by negro blood. The original inhabitants of Aïr were negroes (Hausa), and an affiliation with Egypt is traced in certain of the non-Berber peoples of that region. The Tibbu or Teda of Tibesti may be classed as Berber negroids. Many Bedawin tribes in the Eastern Sahara claiming Arab descent are really of Hamitic stock, as are also several of the "Arab" tribes of Nubia, Kordofan, etc.

The Berbers in the Sahara, as in the Barbary States, have in the main preserved their racial purity and their pre-Islamic polity. This is worth noting on economic grounds, for the Berber, unlike the Arab, is, wherever circumstances permit, a tiller of the ground. The Arabs have in two respects, however, made their mark on all the Berber tribes—they have imposed their language † and their religion on all North Africa. All the dwellers in the Sahara are Mohammedans,‡ and especially in the Eastern Sahara

* There is some evidence that this area—a typical intermediate zone—is again becoming more humid. See Prof. Gregory's paper in the *Journal*, vol. **43**, p. 299, and the authorities there cited.

† The Berber tongue is still very largely used, but Arab is the general vehicle for speech and writing.

‡ Some tribes on the borderland of the Sudan are pagan and among those tribes the French wisely discourage Islamic propaganda.

large numbers are members of the Senussi fraternity, a sect which has shown much hostility to European influence and has contested foot by foot the advance of the French in the district east of Lake Chad.*

As to the population of the Sahara only of those who dwell in the Egyptian oases and the Algerian Sahara are there accurate census returns. In the Egyptian oases, including the Fayum, there are about 160,000 inhabitants (the last census was in 1907); in the Algerian Sahara there were 494,000 in 1911, including 9000 Europeans (French, Maltese, Italians, Greeks). All the rest is simple estimation. The French authorities give 222,000 as the population of Mauritania and 800,000 for the rest of the Western and Central Sahara. There may be 100,000 in the Moroccan Sahara and 50,000 in Rio de Oro. For the Eastern Sahara, inclusive of Tripoli and Cyrenaica but exclusive of the Egyptian oases and Tibesti, Borku and Endi, 1,180,000 was Mr. Oric Bates's estimate in 1912; for Tibesti, Borku and Endi 250,000 appears a generous allowance. This gives in round figures a total of 2,250,000, and it probably exceeds the real number. If the Fayum be excluded, and it may well be considered part of Egypt proper, and also the city of Tripoli with its 60,000 inhabitants, we get as the population of the Sahara something under 2,000,000, of whom nearly a fourth is found in the Algerian Sahara. The majority of these 2,000,000 people are nomads, but the nomads are more dependent on sedentary settlements, *i.e.* towns, than might be thought. Fixed centres are essential for their existence; to these they have to resort for their markets and their news and everything which connects them with the outside world. Saharan towns—which have a population of from 2000 to (rarely) 10,000—are either agricultural settlements in large oases or are on the routes to and from the Sudan and the Mediterranean; often a Saharan town fulfils both conditions. We have already named the towns in the Algerian Sahara. The other chief towns in the Sahara are Ghadames and Ghat on the Tunisian-Tripoli frontier; Murzuk in Fezzan, Bilma (between Murzuk and Lake Chad), Aujila and Siwa on the inland route from Tripoli to Egypt; Jof in Kufra; Bardaï in Tibesti. In the Central Sahara Agades in Aïr has already been mentioned, and Taudeni the most important place on the route from Tafilalt to Timbuktu. In the Sahel Sudanese Walata, north-west of Timbuktu, is of much less importance than it was formerly, but it is a French administrative post. Between the Niger and Lake Chad is Zinder which, however, may be regarded as in the Sudan rather than in the Sahara. The life of the nomad is confined as a rule to the regions around these centres; in the rains he will go as far afield as he can get pasture for his camels and his horses, but when the pastures dry up he returns to the oases. In the more arid regions

* Neither has the Senussi policy looked with much favour on the Turks. The fraternity has played a part in opposition to the Italians in Tripoli and Cyrenaica—on material as well as religious and political grounds—but it has preserved a friendly neutrality towards Egypt and the Government of the Anglo-Egyptian Sudan.

he keeps to the tracks along which small oases and *hattiahs* lead to the larger settlements: *hattiahs* are halting-places where grazing may be had, but, usually, no water.

The chief commodities of the Sahara are the date palm, the camel, and salt. The milk of the camel is the common drink throughout the Western Sahara.* Raiding is or was a pastime and pleasure. The favourite object of the raids was a rich caravan carrying merchandize, slaves, and eunuchs (for the harems of the East) from the Sudan to the Mediterranean. At such towns as Ghadames and Timbuktu the nomad got and gets the products of the Sudan and the Barbary States and also goods imported from Europe. The convoying of the caravans afforded employment to a number of these nomads. The Berber tribes, besides cultivating the soil wherever opportunity offers, have a few primitive manufactures, such as the weaving of woollen garments and the making of carpets of goat and camel hair.

European Influence on the Life of the Saharans.—The preceding brief and inadequate sketch of the traditional manner of life of the desert dwellers shows that in many respects it was incompatible with Western ideals and would be modified when the Sahara came under European control. The changes in the customs of the Saharans are due to two causes: (1) the enforcement of "law and order" in the desert itself, and (2) the economic changes wrought by the establishment of European authority in the lands bordering the Sahara. To-day the whole of the North African states are in the hands of Europeans, while France and Great Britain between them hold the Sudan from Cape Verde to the Red Sea.† Only in Darfur has a native Sudanese government in touch with the Sahara any real authority, and Darfur is a tributary state of the Anglo-Egyptian Sudan. This European control of the Sudan and of the Barbary states means, in the first place, the suppression of the slave trade. After other routes had been closed slaves were still smuggled to Morocco from the Western Sudan, and small consignments went from Wadai, Tibesti, Borku, and Endi across the Libyan Desert to Cyrenaica and Tripoli, where with the connivance of Turkish officials they were disposed of clandestinely. This trade was not large in recent years but it existed. In 1909–10 the French conquered Wadai, in 1912 the Italians seized Tripoli and Cyrenaica, in 1913–14 Borku and Endi were occupied by the French. The establishment of a French protectorate over Morocco in 1912 was followed by the suppression of the slave markets in that country. Thus the Saharans have been deprived of one means of livelihood; they can neither buy nor convoy slaves. There has been an even greater interference with their legitimate trade. Until the belt of primæval forest which stretches across

* P. Marty, *op. cit.*

† Germany had a small share of the Sudan around the south of Lake Chad. This she has lost.

the Western Sudan was pierced the trade of the Sudan went either north to the Mediterranean or east to the Red Sea at Suakin,* while the commerce of the Barbary States with the Sudan had likewise to go across the desert. The first efforts of the French and British to trade with the Sudan by the Gulf of Guinea had little effect in the Sahara. The case was altered when the French brought a railway from Senegal to the middle Niger and opened a route to Timbuktu from the west, and the British built railways from Lagos and the lower Niger to Kano. From Senegal to Lake Chad trade has for some years now increasingly followed the safest, cheapest, and (though a minor matter) the quickest routes—those to the south and west. The people most affected by this deflection of trade from the Saharan route—in addition to the nomads who either plundered or guarded the caravans—were the merchants of Murzuk, Ghat, Ghadames, and Tripoli. The Tripoli-Chad-Kano route had been for over a century the most famous of all the caravan routes across the desert, surpassing in importance that from Timbuktu to Fez. The wars of Rabah, Zobeir Pasha's ex-slave, who conquered the Chad countries in 1891–93, rendered the route insecure, and when order was restored and Northern Nigeria came under effective control the merchants of Kano and Bornu had begun to look to the Gulf of Guinea as the proper outlet of their commerce. The trade of the French East Nigerian territory is also encouraged to take the southern route. Zinder is recognized as a commercial dependency of Nigeria. These facts and the war between Italy and Turkey in 1911–12 almost killed the caravan trade on the great Saharan highway. The French in Tunisia and the Italians in Tripoli, with reason, believed that the trade might be revived and measures which may have led to success were being taken † when the outbreak of the war in Europe was followed by serious revolts against Italian authority. The result has been that the Italians have withdrawn for a time from Fezzan and Ghat. In the Sahara they now hold only Ghadames. The prospects of any great revival of trade with the Sudan across the Sahara are not encouraging. It must be remembered that only goods of considerable value can pay the cost of transport, especially since the most valuable form of currency —slaves—is no longer available.‡ Ivory, ostrich feathers, leather goods, gold-dust always paid for transport; yet the annual average value of the

* The building of a railway from Kordofan to the Red Sea tends to emphasize this west to east inclination, yet, owing to greater prosperity, Sudanese trade with Egypt *vid* the Nile has increased and not decreased.

† The *Primo Maggio*, an Italian journal published in Tunis, poured scorn on the results obtained—three caravans in two years; a few thousands of ostrich plumes, a few hundreds of elephants' tusks, and skins of animals, all in transit for England or Germany!

‡ Slaves, cheap in the Sudan, were employed to take the other merchandise across the desert, and they themselves fetched good prices in the markets of North Africa.

caravan trade brought to Tripoli for the forty years ending 1901 was but £114,000.

There are, however, the wants of the Saharans to be supplied; cottons, tea, and sugar are in constant demand. There is no reason to despair of creating a trade with the desert peoples which shall take the place of the transit trade from and to the Sudan.* The suppression of raiding and inter-tribal fighting will ultimately tend to an increase of productivity and trade in the inner Sahara (as it has already done in the Algerian Sahara), for if the raider cease from raiding he must turn his hand to some other employment. In the present transitional stage it is undeniable that life for the Saharans has been made harder and more drab. The increase of means of communication and the safety of travel will have their effect on future generations.

This question of internal security has been practically solved by the French whose sovereignty is now unquestioned over the greater part of the Central and Western Sahara. The only other European power there with territorial possessions is Spain. In the protectorate of Rio de Oro Spain has a seaboard with one good harbour and a hinterland of limited extent but considerable potential value. At present Spanish authority is not effective save at a few places on the coast, and the adjoining Moroccan Sahara is still in fact outside French jurisdiction. But nearly all the tribes in Mauritania have, after hard fighting, acknowledged French sway. (Important chiefs hitherto hostile made submission at the close of 1914.) More remarkable perhaps is the rapidity with which, since the conquest of the Algerian Sahara was completed in 1901 by the occupation of Tuat, the Taureg of the Central Sahara have been brought into friendly relations with France. The pacification of Tripoli and its hinterland by Italy is postponed owing to the Great War, but unless the Senussi should make a great effort it is not likely to be delayed much beyond the close of the war. The Italian annexation of Tripoli solved one question which, in the opening years of this century, promised to give trouble—the extension of Turkish authority in the Central Sahara and the Libyan Desert. Turkey is no longer an African power, her last political link with the continent being broken in December, 1914, by the proclamation of a British protectorate over Egypt. There remains the settlement of the boundaries of the Italian sphere, a settlement which affects French and British (Egyptian) interests. The exact frontiers of Libya (as the Italians style their North African possessions) is a matter of some importance, involving the control of the routes to the Central Sahara and the possession of the Kufra oases.† The solution of this question will help materially in the pacification of the Sahara, for the

* See *infra*, "Possibilities of the Land."

† See "Egyptian and Sudan Frontiers," by F. R. Cana, *Contemporary Review*, May, 1914, *L'Afrique Française*, May, 1914, and *Rens. Col.*, April, 1914.

tribes on the debatable borders will thereafter be made amenable to one power or the other. Meantime France has already found a congenial means of employment for some of the tribesmen she has tamed. The policing of the Sahara is confided to the men who but lately were the disturbers of the peace. The meharist companies (men mounted on swift riding-camels) led by French officers do their work effectively. A considerable number of Berbers from the Sahara are, too, fighting to-day in France in the ranks of the Moroccan and Algerian regiments. They have carried their aptitude for war to Europe, and have shown a degree of discipline which has won the direct commendation of General Joffre.

Means of Communication.

Something has been done to render travel on the chief caravan routes less arduous. Thus the French have a post at Bilma on the Kano-Tripoli route, and there are fixed stations between Zinder and Agades and from the Senegal to Mauritania. These routes are regularly policed by meharists and the water-supply has been improved. All that can be done by these methods will be done, and it means much to travellers and all who use the desert to be able to travel without fear of being plundered and with less risk of dying from thirst.* Caravan tours across the Sahara may well be organized by the tourist agencies in a not distant future. Meantime the opening up of the desert by railway has begun.

Railway projects in the Sahara are of two kinds: (*a*) those intended for a local and circumscribed purpose; (*b*) those which look forward to the junction of the railways of the Barbary States and Egypt with the Sudan. Some of the lines in class (*a*) will eventually become part of system (*b*). We may take first the lines built for special or local reasons. These have so far reached their greatest development in the part of the Sahara east of the Nile.† The well-known rail and river route from Cairo to Khartum is a trans-Saharan route. Egypt is but a long oasis in the Sahara and the Nubian Desert is as much part of the Sahara as is Mauritania, and is much more arid. But the railway from Halfa to Khartum was built for military and political reasons and from its situation east of the Nile has little influence on developments over the rest of the Sahara. The railway from Atbara (on the Halfa-Khartum line) to Port Sudan on the Red Sea is also a purely Saharan line. Its purpose too is local, to get the products of the Eastern Sudan by the quickest route to the world's markets. Neither the Khartum nor the

* A recent picture of the Tripoli-Chad route is given by Hanns Vischer in 'Across the Sahara from Tripoli to Bornu' (London, 1910).

† The Sahara is often regarded as ending eastward at the Nile. Geographically incorrect, this is a convenient boundary for many purposes. In France the tendency is to exclude the Libyan Desert from consideration when dealing with the Sahara. These distinctions arise chiefly from political causes.

Red Sea railway was built to serve the deserts across which they run. They do not even pass through any oases.

Of local railways west of the Nile in the Sahara there are two or three. Kharga, "the Great Oasis," has been linked by rail to Cairo since 1908. This is a type of the local lines which serve oases sufficiently fruitful—or capable of being rendered sufficiently fruitful—to make it worth while to encourage trade with the outer world. Going westward from the Nile valley the only railways built which penetrate the Sahara are those starting from Algeria. A beginning has, however, been made by the Italians in Tripoli. From Tripoli city a line has been planned to go south to Murzuk in Fezzan. Good progress had been made with the first section, to Gharian, but work on the line was suspended in the spring of this year in consequence of the spread of the revolt which broke out in Fezzan in September, 1914.

The Algerian Sahara has two railway systems. One line from Oran crosses the High Atlas by Ain Sefra and continues south-west by Figig to the oasis of Colomb Becher. This line though built for military reasons is however commercially valuable. It leads to Igli and the fertile oases of Tuat. The continuation of this railway from Colomb Becher by Igli along the Soura valley to Adrar in Tuat has been decided upon. The French trans-Saharan railway, when built, will pass through Adrar, so that the Tuat line will become of double importance. The second railway in the Algerian Sahara is that which from Constantine crosses the Aures Mountains to Biskra where for several years it ended. Biskra stands at the northern end of the caravan route to Tuggart and Wargla, a route which passes through several oases. It is a region where there are many possibilities of development and it was regarded until the last few years as the probable line which the trans-Saharan railway would take. The Algerian Government some time ago decided that in any case the Biskra railway should be continued to Wargla and the first section—Biskra to Tuggart—was begun in 1911 and opened for traffic in May, 1914. This section is 124 miles in length, is of metre gauge, and cost £380,000. As illustrative of the topography of this region it may be mentioned that this railway in its short course passes through six oases, several stretches of bare desert, skirts the salt-encrusted Shat Meruane (the western arm of the Shat Melrir), and crosses the Wadi Jidi—which is subject to violent and dangerous floods—by a bridge 300 metres (nearly 1000 feet) long. The chief oasis served is that of the Wadi Rhir famous for its date palms.* One of the intermediate stations, near to the Shat Meruane, is named Kel el Dor (the Rock of the Turning Back). This name preserves the memory of a legend that here a Roman legion from Timgad advancing towards the Wadi Rhir turned back stricken with fear at finding all their weapons completely rusted. These old legends

* For fuller details of the line, see *L'Afrique Française* for May, 1914.

have their value, and when tourists flock to Tuggurt (preparations for their reception are being made by the erection of hotels with all modern conveniences), a halt at Kef el Dor and an excursion to the Shats will be part of the programme. A branch line westward (53 miles long) up the Wadi Jedi to Walad Jellal has been surveyed, while the main line will pass by the oasis of El Kedir to Wargla which will be 105 miles by rail from Tuggart.

Half a dozen routes have been suggested for the railway which, since the occupation of Timbuktu in 1894, has been ardently desired by the French colonial party. In February—September, 1912, Captain Nieger was at the head of a mission which made a careful survey of the ground and the route he suggests seems likely to hold the field. The line he has traced runs south-east from Adrar in Tuat to El Aulef at the western end of the Tidikelt oasis (whence a branch line might go to In Salah). From El Aulef the railway would traverse the wadis—where water can be got by artesian boring—between the Ahnet and Muidir plateaus.* Thence turning more directly south the line would keep west of the Ahaggar mountains and on to the oasis of Silet with its numerous date palms. From Silet the route is over the Tanezruft south-east to Agades in Aïr. At two places—In Guezzam and In Amauel—in this dreaded Tanezruft, which Captain Nieger took forty-two days to cross, there are however inexhaustible supplies of water, and at a third place, Tinrerho, there is a supply which could be much augmented by artesian borings. Rounding the south of the Aïr highlands the railway would go by Zinder to Lake Chad, skirt the northern end of that lake and reach its eastern side. Its further connection with the Congo river did not concern Captain Nieger. It will be seen that the line suggested aims at reaching Central and not West Africa. The connection with West Africa is proposed to be made by a branch which would leave the main line south-west of Silet and traverse the western side of Adrar Iforas. It would reach the Niger at Tosaie (below Timbuktu), that spot having been chosen as there the river can be fairly easily bridged. An alternative route which would keep east of Adrar Iforas and strike the Niger at Gao was surveyed. The connection of Morocco with the Sudan could be made should the Nieger proposals be adopted by building a railway from Fez to Tuat.

The surveys of Captain Nieger, Captain Maurice Cortier, the second in command, and other members of the expedition showed particularly how level is the general surface of the Saharan tableland and how free its surface is from sand-dunes. Captain Nieger reported † that along the whole route he suggested from Tuat to Lake Chad—including the branch

* Alternatively the line might keep west of the Ahnet plateau.

† 'La Mission d'Etudes du Chemin de Fer Transafrican,' *L'Afrique Française*, 1913, p. 5; 'Résultats scientifiques d'ensemble de la mission du Transafrican,' *La Géog.*, 1914, p. 73.

to the Niger—important embankments, cuttings, and moving sand are avoided; the railway, he says, encounters no serious obstacle and over the greater part of the route it is simply a question of fixing the sleepers and laying down the rails. In one place between Aïr and Lake Chad the line would have to cross a sand-belt of fixed dunes partly covered with vegetation and only 22 miles across. The length of the line from Colomb Becher to Lake Chad would be 1700 or more miles—about four times as long as the line from Halfa to Khartum. Of the practicability of building such a railway there is no doubt; the question is one of utility. It would not in any event attract the trade of West Africa to take the long land journey by rail when the markets of the world can be reached more easily and cheaply by the sea route; still less likely does it seem that it would attract the trade of the northern Congo regions. It would however have strategic value and it would bind together the French possessions in North, West, and Central Africa. Perhaps the strongest reason for its construction is that nearly two-thirds of the proposed Algeria-Chad route will be served by railways in any case. Political and economic reasons combine to cause the French to carry the Colomb-Becher line to Tuat, and the same reasons will cause the linking up of Zinder with Agades in the north (and Kano in the south). That being the case there will remain only the gap between, say, Adrar in Tuat and Agades. This gap of about 800 miles is the precise region where the railway can be most easily and cheaply made, and if only for the sake of symmetry and completeness the gap is likely to be bridged.

There are other reasons why the Lake Chad end of the line will be built. The effective development as well as peaceful control of the intermediate zone between Lake Chad and the Nile is best assured by rapid means of communications. At the eastern end a beginning has been made by the building of the railway from Khartum to El Obeid in Kordofan, and at the Chad end a few miles of rails have been laid down by the French. It requires, indeed, no gift of prophecy to foresee the day when a railway will stretch from Dakar to Port Sudan fed by branch lines north and south.

Another east and west trunk-line which has direct connection with the Sahara is in the making—the railway which will run parallel to the coast of the Mediterranean from Tangier to Alexandria. From the Gulf of Gabes eastward to Egypt the coast lands, if not part of the Sahara, have a Saharan character. A railway along this section of the coast until recently seemed a thing of the dim future. The aspect is now altering. Some year or two ago the French began to extend the Tunisian railways from Sfax to Gabes, and these railways are now to be continued to the frontier of Tripoli, while a line inland from Gabes to capture the trade of Ghadames is proposed.* The Italians, besides the line inland to Fezzan,

* The French are endeavouring to open up a new "through" caravan route from Gabes to Lake Chad, skirting the western frontier of Tripoli. It will pass by way of

are also building coast lines both east and west from Tripoli city. The western line, which was completed as far as the oasis of Zauia in October, 1914, will link up with the Tunisian lines. The eastern line will in time reach the Egyptian frontier at Sollum. A section of this eastern extension has been begun independently, the Italians having determined to connect Benghazi and Derna by rail as soon as possible. The first little section of 12½ miles eastward from Benghazi to Benina was opened in September, 1914. Something also has been done from the Egyptian side. The ex-Khedive, Abbas Hilmi, convinced that there was a profitable trade to be done with the Bedawin of the Libyan Plateau, built a line (since bought by the Egyptian Government) westward from Alexandria to Bir Fuka (120 miles). Thus fragments of the line which will form the eastern section of the Tangier-Alexandria trunk railway are in existence. They should help in the restoration of prosperity in Tripoli and Cyrenaica and branch lines may aid in creating industries and trade in the hinterland

An extensive telegraphic system has been established in the French Sahara and some small use has been made of motors. Wireless telegraphy stations have been erected at Timbuktu, Colomb Bechar, and Port Étienne.

Possibilities of the Land.

Regarded from the point of view of the contribution it may make to the world's wealth the Sahara does not seem a promising field. Yet it possesses one thing for which there is a great and apparently increasing market—dates. There are many millions of date-palms in the Sahara; millions more might be grown, and the Sahara dates are unequalled in quality. The difficulty is in getting them to market, and such railways as that recently opened to Tuggurt give the needed facilities. Information given by Commandant Godefroy—who both surveyed and built the Tuggurt line—with regard to the production of the Rhir oases may be given as typical of the work carried out by France in the Algerian Sahara generally. In 1856 the Rhir had 200 wells and 339,000 date palms. In 1914 there were over 800 wells and nearly 1,500,000 palms. Since the French occupation the production of dates had nearly quadrupled and was in 1914 some 30,000 tons. This was accomplished before the railway gave the people of Rhir the chance of putting their dates on the market. This year it was anticipated that 8000 to 10,000 tons of dates, worth about £16 a ton, would be exported from Rhir, and with the coming of the railway the area of plantation can be very largely increased. Commandant Godefroy estimates that the Rhir can produce for

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the oases of Janet (near Ghat), Jado, and Bilma. A copious supply of good water was found by boring at a spot 19 miles south of Ghadames. The first caravan left Gabes in April, 1913. This route, should it be much used, will diminish the importance of the Chad-Tripoli route.

exportation dates worth nearly £500,000 yearly. Already some French colonists have acquired palm groves. This example of what can be done in one oasis must serve to indicate what is being done in many others. When all the oases in the Moroccan, Algerian, and Tunisian oases are brought to full productivity and given easy means of access to the North African ports, the date industry should attain proportions as large as any demands made upon it. More distant oases can also be made more flourishing and thus able to support a larger population —all needing European goods.

The date palm is rightly called the monarch of the Sahara, but it has subjects. A great variety of fruits—peaches, grapes, oranges, figs, and the more hardy apple, etc.—are grown in the oases and there are possibilities of a valuable export trade in them. Moreover, a large range of crops from wheat and barley to rice and durra can be grown. These will not become exports, but if all the chances of cultivation were seized the Sahara could support a much larger population than it now does. Two things are requisite for the cultivation of the oases to their fullest capacity—water and security of tenure. The French are providing both. Besides the sinking of artesian wells, the usual method of getting new supplies of water in the oases, surface irrigation works are being undertaken in Tuat where there is a large supply of river water.

Another source of sylvan wealth is afforded by the gum acacias. These are found in oases but chiefly in the intermediate zone bordering the Sudan. In these regions too are found the ostriches whose feathers have for centuries been one of the chief articles of Saharan commerce. There is no reason why ostrich farming in this "strip of herbage strown" should not become very valuable. In Mauritania many of the uplands appear to be suitable for stock-raising on a large scale and Port Étienne and Villa Cisernos afford convenient harbours for their export. The thousands of camels, asses, goats, and sheep possessed by certain tribes proved the existence of large areas of pasturages. The present trade in hides and skins is obviously capable of material expansion. Probably esparto might be cultivated here as it is in the Algerian plateaus, and Mauritania with its harbour of Port Étienne seems to deserve to be supplied with a railway system.

Although the Sahara may be the least curable of deserts actually the area where increased cultivation of the soil is possible and would be profitable is large. It cannot well be less than a tenth of the whole area—say 350,000 square miles, or something less than the combined area of France and Spain. This would include the Sahel Sudanese, the intermediate zone mentioned several times already. There appears to be no sufficient climatic reasons to prevent Fezzan, the Zinder district, the Aïr highlands, and the Walata valley recovering the prosperity they formerly possessed. The region of the Middle Niger—the backwaters and lakes which extend westward of Timbuktu—could at comparatively little cost

be placed under irrigation.* Means could in all probability be found for restoring to cultivation large areas between Lake Chad and Borku. In the bed of the Bahr el Ghazel wells already exist and their number could be increased by boring. Efforts to regenerate the intermediate zone are, naturally, likely to take second place to the development of the richer regions further south, but work in that zone has the recommendation that it will form a protection against further encroachment by the desert.

As to mineral wealth the Sahara is rich in salt. Phosphates, potash, and soda are found; the great beds of phosphates exploited in Algeria and Tunisia lie on the Saharan border. There is a regular export of potash from Aïr to Nigeria. Gold and precious minerals were mined by the ancient Egyptians in the hills facing the Red Sea and gold-mining on a small scale has begun again in the Nubian Desert. Soda in large quantities is obtained from the Natron lakes west of Cairo, from the Chad district and other regions. Petroleum-bearing strata are believed to exist. But the mineral resources of the Sahara are practically unknown, though the belief that they are great is probably well founded.

When all has been done for the economic development of the Sahara which is possible, when France, Great Britain, and Italy between them maintain peace throughout its wide extent, when a population ten times as numerous as it now is finds in it means of support, the desert will in outward aspect be little altered. It will remain a land of immense solitudes and boundless horizons, of strange dead mountains and dry river-beds, of verdant oases, waving palms and ever-receding mirages—a land of heat and thirst, of rock and dune, in which the tents of the nomads and the caravans of camels will leave a more lasting impression than the lines of steel which bind it anew to the outer world.

EARTHQUAKES IN GREAT BRITAIN (1889–1914).

By CHARLES DAVISON, Sc.D., F.G.S.

During the twenty-six years considered in this paper the total number of known earthquakes is 357. The average annual number is thus 13·7, or slightly more than one a month. The annual number, however, is extremely variable. No year was entirely free from earthquakes, though in each of three years (1897, 1899 and 1914) only one earthquake is recorded and in each of three others (1895, 1902 and 1913) only two. Some years were unusually rich in earthquakes, 18 shocks being felt in 1908 and 1909, 19 in 1891, 20 in 1892, 21 in 1910, 23 in 1901 and 1906, 26 in 1890, and 74 in 1912.

The more important earthquakes as well as many of the slighter

* See 'Haut-Sénégal-Niger. Géographie Economique,' by J. Meniaud. Paris, 1912.

shocks (altogether 130 in number) occur sporadically in different parts of the country, seldom visiting the same district except at long intervals, and differing chiefly from the great earthquakes of seismic countries in their slighter intensity and in the greater duration of the intervals of quiescence. They include such strong earthquakes as those of Inverness in 1890 and 1901, Pembroke in 1892 and 1893, Hereford in 1896, Derby in 1903 and 1904, Carnarvon in 1903, Doncaster in 1905, and Swansea in 1906. These 10 earthquakes which, with their associated shocks, account for 77 of the 130 earthquakes originated in at least eight different seismic centres. The Derby earthquakes originated in the same double focus, the Inverness earthquakes probably in the same focus. There are also a few other districts in each of which two or three earthquakes of minor importance originated. Otherwise each of the centres responsible for the above earthquakes has been disturbed only once during the twenty-six years and indeed for many years before 1889.

The remaining earthquakes (227 in number) are of somewhat unusual character. They belong to two series of shocks closely resembling those which during the last century made the name of Comrie famous. They are of special frequency for this country, rarely attaining any considerable strength except near their centres, and originating for the most part beneath an area of not more than a few square miles. The earlier series of 41 earthquakes occurred in Glen Garry in Invernesshire from 1889 to 1899; the later, of 186 earthquakes, in the district bordering the southern slope of the Ochil Hills between the years 1900 and 1914. Throughout the period considered the Comrie centre has been almost in a state of quiescence, only three slight earthquakes having been recorded, in the years 1894, 1895 and 1898.

Methods of Investigation.

It may be convenient if I give here a brief account of the methods of investigation which I have used in studying British earthquakes. The methods are based on the modern view as to the origin of earthquakes, that they are for the most part the result of tectonic operations and especially of the growth of faults. No recorded British earthquake has ever been accompanied by perceptible crust-displacements at the surface. We may therefore look upon our earthquakes as the transitory effects of the waves of vibration generated as one rock-mass adjoining a fault slides over and against the other.

In such cases the seismic focus (or region within which the initial impulse is produced) is a portion of the fault-surface. For our present purpose it may be regarded as a plane surface inclined to the horizon, and, as a rule, of much greater dimensions in the horizontal than in the vertical direction. In the simplest case the relative displacement of the rock-masses adjoining the fault is greatest in the central portion of

the focus and decreases gradually towards the margins until it dies away.

Determination of the Originating Fault.—It is evident that a focus of such a form and position must affect the distribution of intensity on the surface of the ground. This distribution is represented by means of isoseismal lines, or lines passing through all places at which the maximum intensity of the shock is the same, the intensity being usually determined by reference to an arbitrary scale, such as the modification of the well-known Rossi-Forel scale given below. Conversely, from the forms of the isoseismal lines it should be possible to infer the direction of the originating fault, its hade or the direction in which it is inclined, and approximately the course of the fault-line on the surface. Also, from the dimensions of the isoseismal lines we may form a rough estimate of the horizontal length of the seismic focus. It will be sufficient here to state the conditions which determine the elements of the originating fault. They are as follows :

1. When the isoseismal lines are much elongated the direction of their longer axes is approximately the direction of the originating fault.

2. On the side towards which the fault hades the isoseismal lines of a weak earthquake are farther apart than on the other side ; those of a strong earthquake are farther apart at a short distance from the epicentre and closer together at a great distance.

3. The fault-line must be nearly parallel to the axis of the innermost isoseismal, at a short distance from it and on the side of it opposite to that towards which the fault hades.

4. The length of the seismic focus is approximately equal to the difference between the length and width of the inner isoseismals.

The Exmoor earthquake of January 23, 1894, may be offered as an example of these methods. The shock was a slight one, in no place of intensity higher than 4 (see the scale of intensity given below). The two curves on the map (Fig. 1) represent isoseismal lines of intensities 4 and 3, the latter forming the boundary of the disturbed area. Both curves are elongated ellipses and their longer axes are parallel, being directed E. 22° S. The isoseismal 4 is $22\frac{3}{4}$ miles long and $12\frac{1}{4}$ miles wide, the isoseismal 3 is $29\frac{3}{4}$ miles long and $16\frac{1}{2}$ miles wide, the distance between the curves being $1\frac{1}{4}$ miles on the north side and 3 miles on the south side. The originating fault must therefore run on an average in the direction E. 22° S., it must hade toward the south, and the fault-line must pass a short distance to the north of the centre of the isoseismal 4. Its probable course is represented by the broken line on the map.

A short time after the earthquake occurred the late Dr. Hicks published his first paper on the "Morte Slates" (*Quart. Journ. Geol. Soc.*, vol. 52, 1896, pp. 254–272). "A great thrust fault," he says, "extends continuously along the northern boundary of the Morte Slates, from the coast near Ilfracombe to the Exe Valley. On the south side there is

evidence generally also of a well-marked fault." These faults hade towards the south. In the map (Fig. 1) they are represented by continuous lines as far as they are shown in Dr. Hicks' first paper. If the northern fault were to bend round as shown by the dotted line and then continue as represented by the broken-line, it would satisfy all the seismic conditions. Without knowing the real course of the fault I sent my map to Dr. Hicks and he returned it with the course as mapped by him, which coincided almost exactly with that suggested by the seismic evidence. This coincidence thus seems to support both the theory of the origin of earthquakes and the methods of investigation based on it.

Scale of Seismic Intensity.—The scale which I have used in studying

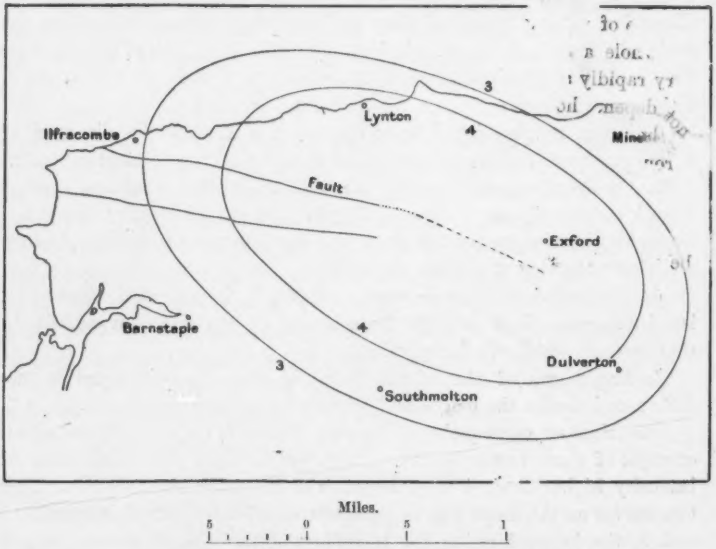

FIG. 1.—EXMOOR EARTHQUAKE OF JANUARY 23, 1894.

British earthquakes is founded on the well-known Rossi-Forel scale. The number of tests is reduced to one for each degree, thus allowing the isoseismal lines to be drawn with greater accuracy than is attainable in a less thickly populated country, in which single tests might result in insufficient observations. The following is the scale :—

1. Recorded only by instruments.
2. Felt only by a few persons lying down and sensitive to weak tremors.
3. Felt by ordinary persons at rest.
4. Windows, doors, fire-irons, etc., made to rattle.
5. The observer's seat perceptibly raised or moved.
6. Chandeliers, pictures, etc., made to swing.

7. Ornaments, vases, etc., overthrown.

8. Chimneys thrown down and cracks made in the walls of some, but not many, houses in one place.

9. Chimneys thrown down and cracks made in the walls of about half the houses in one place.

The first seven degrees of this scale correspond to the same degrees of the Rossi-Forel scale, and the last two to degree eight of that scale.

Sound-Phenomena.—Considerable use is made of the sound-phenomena in studying British earthquakes. The principal sound-vibrations are close to the lower limit of audibility, a limit, moreover, which is variable in different persons, so that in one place and even in the same house the sound may be heard by some observers and be inaudible to others who are equally attentive. The percentage of audibility, or the percentage of persons who hear the sound within a given area, declines on the whole as the distance from the epicentre increases, slowly at first, very rapidly as the boundary of the sound-area is approached. It does not depend, however, only on the distance, and the decline in audibility therefore is represented by means of isacoustic lines, or lines drawn through all places within which the percentage of audibility is the same.

Description of Some Typical Earthquakes.

I will now give brief descriptions of some earthquakes which may be regarded as typical of British earthquakes in general. The earthquakes selected are the Inverness earthquake of 1901, the Ochil earthquakes of 1900–1914, the Hereford earthquake of 1896, and the Derby earthquake of 1903. It will be seen that the first two and the last two are representative, respectively, of the two chief classes of British earthquakes.

1. *Inverness Earthquake of September* 18, 1901.—This earthquake, one of the strongest of all Scottish earthquakes, disturbed the whole of Scotland with the exception of the southern counties. The isoseismal lines (corresponding to intensities 8–4 of the scale given above) are represented by the curves in Fig. 2. Within the isoseismal 8 many houses were slightly damaged; near its centre, which is about two or three miles south-west of Inverness, walls were cracked and chimneys thrown down. The outermost curve (an isoseismal of intensity 4) bounds the disturbed area, which is 215 miles long from north-east to south-west, 198 miles wide, and includes within it about 33,000 square miles, an area approximately equal to that of Ireland.

Throughout the whole of this area the shock was almost uniform in its nature. At Inverness, for instance, there was first a gentle movement followed by a quivering which increased in force for two or three seconds and then decreased for two or three seconds; just as this quivering was about to cease there was a distinct heave, after which the vibration was much more severe than before. The shock thus consisted of a single series of vibrations with two maxima of intensity, of

which the second was the stronger. At some distance from the epicentre the intermediate tremors were imperceptible and the shock consisted of two parts corresponding to the two maxima observed at Inverness.

The innermost isoseismal (that of intensity 8) is an ellipse 12 miles long and 7 miles wide, with its longer axis directed N. 33° E. The isoseismal 7 is 53½ miles long and 35 miles wide, its longer axis being

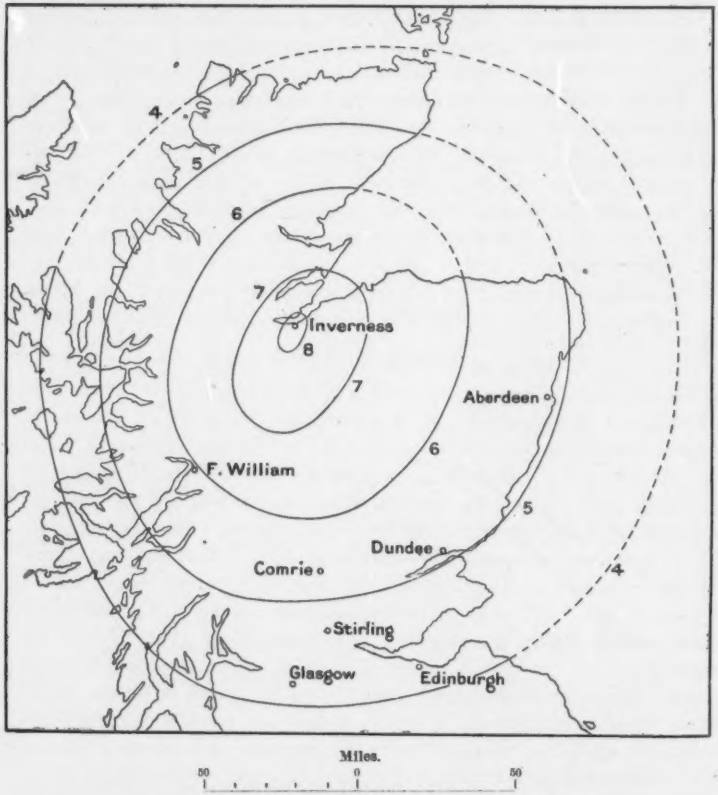

FIG. 2.—INVERNESS EARTHQUAKE OF SEPTEMBER 18, 1901.

parallel to that of the isoseismal 8. The distance between the two curves is 9 miles on the north-west side and 14 miles on the south-east side. It may be inferred that the originating fault runs parallel to the longer axes of these curves, that it hades (or is inclined) to the south-east, and that the fault-line lies a short distance on the north-west side of the centre of the isoseismal 8. The chief fault of the epicentral district is the great boundary-fault which runs from Tarbat Ness along the eastern

coast of Ross-shire, and follows the line of the Great Glen. The mean direction of the fault is about N. 35° E., its hade is to the south-east, and the fault-line passes about three-quarters of a mile to the north-west of the centre of the isoseismal 8. It thus agrees with all the conditions demanded by the seismic evidence.

The earthquake was preceded by a slight shock on September 16 and followed by at least seventeen after-shocks. The centres of the innermost isoseismals of the more important of these shocks are represented by the dots in Fig. 3, *a* being that of the fore-shock, B that of the principal shock, and *c*, *g*, *h*, *m*, *n*, *q*, those of the stronger after-shocks. The continuous line shows the course of the great fault. It will be noticed that all these centres lie within a narrow band which is parallel to the fault-line and lies on the side of it towards which the fault hades, thus confirming the conclusion that the earthquakes were due to slips along the great fault.

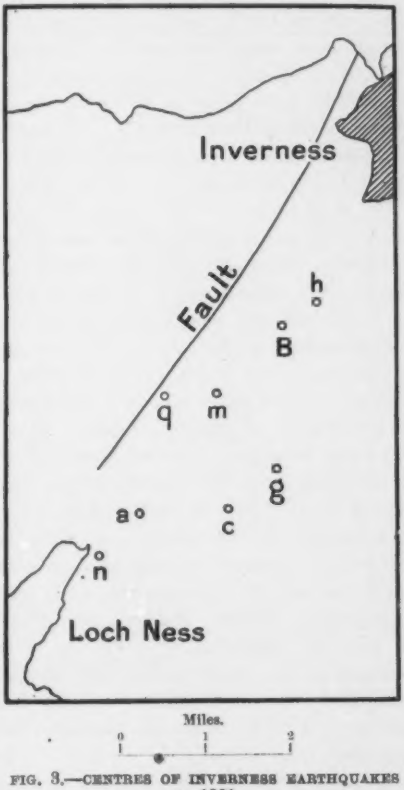

FIG. 3.—CENTRES OF INVERNESS EARTHQUAKES OF 1901.

The great slip which caused the principal earthquake must have been at least 5 or 6 miles in length, reaching nearly from Loch Ness to Inverness. The fore-slip of September 16 occurred near the south-west extremity of the principal focus. Taking into account only the stronger after-shocks there were, within three hours of the great slip, two (*c* and *g*) near the south-west margin of the principal focus. About two hours later the next important slip (*h*) took place on the north-east side of the principal centre, probably extending the focus in that direction. For more than eleven days there was no movement of any consequence. On September 29 a small slip (*m*) occurred about one mile to the south-west of the principal centre, followed in six hours (on September 30) by a long slip (*n*) to the south-west of the principal focus and extending

two or three miles beneath Loch Ness. The last important after-shock (*q*) occurred on October 13 a short distance on the south-west side of the principal centre. Besides the lateral migration of the after-shock centres there was also a continual approach (from $1\frac{1}{2}$ miles to $\frac{1}{10}$ mile) of these centres towards the fault-line, indicative of a decreasing depth in their foci. Thus the results of the great slip which caused the principal earthquake were increases of strain in the marginal regions of the principal focus, and in the portion of the fault above the centre of the focus. The minor slips which resulted from these increased strains thus occurred for the most part in the terminal and central portions of the principal focus, but especially towards and underneath the north-east end of Loch Ness.

2. *Ochil Earthquakes of* 1900–1914.—This remarkable series of earthquakes began on September 17, 1900, and ended on December 18, 1914. The total number of earthquakes included in it is 186, the annual numbers being 4 in 1900, 1 in 1903, 10 in 1905, 19 in 1906, 13 in 1907, 17 in 1908, 18 in 1909, 19 in 1910, 8 in 1911, 74 in 1912, 2 in 1913, and 1 in 1914. The series includes three strong earthquakes, those of September 21, 1905, October 20, 1908, and May 3, 1912. The intensities of these shocks were respectively 6, 7 and 7, and their disturbed areas about 1000 and not less than 600 square miles. Besides these there were 10 earthquakes which disturbed areas ranging from 74 to 136 square miles, the average being about 94 square miles. Of the remaining 173 earthquakes 24 were earth-sounds without perceptible tremor, 101 were of intensity 3, 34 of intensity 4, and 8 of intensity 5, the disturbed area in no case exceeding 60 square miles and being usually much less.

The isoseismal lines of one of the more important shocks (that of September 21, 1905) are represented in Fig. 4. The inner isoseismal is 13 miles long and 8 miles wide, with its longer axis directed E. 29° N., the distance between this isoseismal and the next being $3\frac{1}{4}$ miles on the north side and $2\frac{3}{4}$ miles on the south side. In the 10 earthquakes of intermediate strength the boundary of the disturbed area closely resembled the isoseismal 6 in Fig. 4. There is some variation in the direction of the longer axes of the isoseismal lines, the limiting values being E. $7\frac{1}{2}$° N. and E. 29° N., and the average direction E. 19° N. In the stronger earthquakes the isoseismal lines are farther apart towards the north than towards the south. The weakest shocks of all are felt only in one or more of the villages which lie along a line joining Airthrey and Alva; in the earthquakes of intermediate strength the greater part of the disturbed area lies on the north side of this line. It may therefore be concluded that the average direction of the originating fault is about E. 19° N., that it must hade to the north, and that the fault-line must lie a short distance to the south of the centres of the innermost isoseismals. The well-known fault at the base of the Ochil Hills, the course of which is shown in Fig. 4, satisfies very nearly two of these

conditions. Its mean direction in the epicentral district is E. 13° N., and the fault-line passes through or near the villages mentioned. The direction of its hade is unknown from the geological evidence. There can be little doubt, from the seismic evidence, that its hade is towards the north.

A remarkable feature of the Ochil earthquakes is their great intensity, taking into account the smallness of their disturbed areas. For instance, the principal earthquakes of 1908 and 1912 were both of intensity 7,

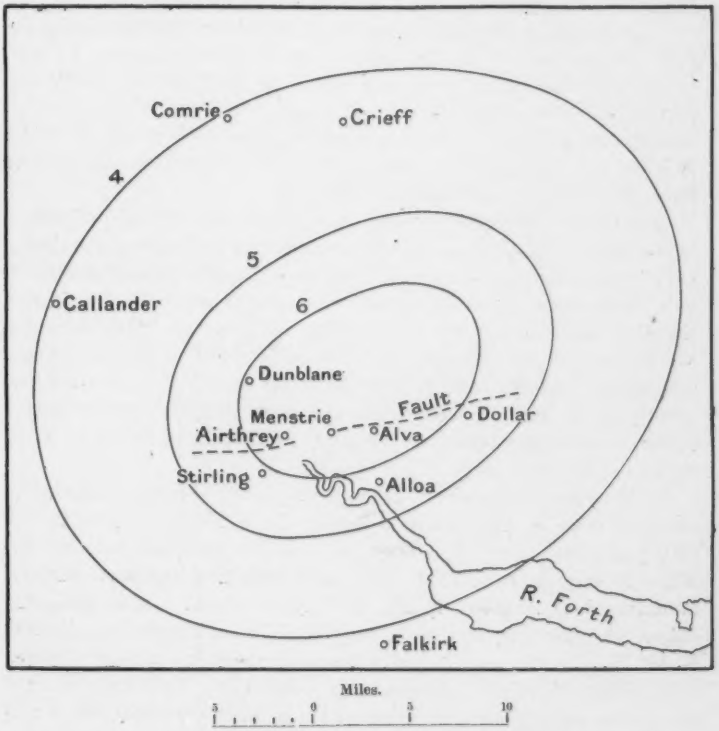

FIG. 4.—OCHIL EARTHQUAKE OF SEPTEMBER 21, 1905.

and their average disturbed area was less than 1000 square miles. The average disturbed area of all the other earthquakes of the same intensity during the years 1889–1914 is 31,000 square miles. We are therefore led to the conclusion that the seismic foci of the Ochil earthquakes must lie at a very slight depth below the surface.

Another feature of some consequence is the brevity of the shock and sound. When the shock is of intensity 4 or higher it usually consists of one or two prominent vibrations followed, and occasionally preceded,

by a brief tremor. When the shock is of intensity less than 4 the prominent vibrations are absent and the shock consists of a brief tremor only. The sound also is usually referred to types of brief duration, the percentage of comparison with such types being 47 for the three principal earthquakes, 54 for those of intermediate strength, and 73 for the slightest earthquakes. We may infer from these results that the focus is usually of small dimensions; and this conclusion is supported by the measurements of the inner isoseismals which give an average of 5 miles for the principal earthquakes and 4 miles for those of intermediate strength.

The portion of the fault along which slips have occurred during the first fourteen years of this century is about 10 miles in length. In order to study the migration of the foci along the fault we may divide this portion into five regions—a central region from Menstrie to Alva, an eastern region near Tillicoultry, a western region near Airthrey, Bridge of Allan and Dunblane, and east-central and west-central regions between the central and terminal regions.

Taking first the three principal earthquakes, that of 1905 originated in the eastern region, that of 1908 in the east-central region, and that of 1912 in the west-central region. Thus, regarding the greater movements only, there was a continual westerly migration of activity. Considering the minor shocks alone this migration is also evident. With the exception of the first two principal shocks, none occurred in the eastern and east-central regions. Throughout the whole period they occurred frequently in the central, west-central, and western regions, predominating in the central region before the principal earthquake of 1912 and in the western region afterwards.

3. *Hereford Earthquake of December* 17, 1896.—Though exceeded in destructiveness by the Colchester earthquake of 1884, no known British earthquake has disturbed so large an area (98,000 square miles) as the Hereford earthquake of 1896. This area, with five isoseismal lines (of intensities 8–4), is shown in Fig. 5. The isoseismal 8 is an elongated ellipse, 40 miles long and 23 miles wide, with its longer axis directed N. 46° W. It includes within it 73 places where marked damage occurred to buildings, the injury to houses being greatest at Hereford and some of the surrounding villages, all lying within a small area near the north-west focus of the ellipse. The distance between the isoseismals 8 and 7 being 20 miles on the north-east side and 13 miles on the south-west side, it follows that the originating fault must be directed about north-west and must hade to the north-east.

In nearly all parts of the disturbed area the shock consisted of two distinct series of vibrations separated by an interval of about 2 or 3 seconds of absolute rest. The two series, however, differed in intensity and duration. The first series of vibrations was the stronger and of greater duration in the north-west portion of the disturbed area, and the second series in the south-east portion. Moreover, the boundary

between these two portions was not a straight line perpendicular to the longer axes of the isoseismal lines, but, as represented by the broken-line on the map, slightly curved, the concavity facing the south-east. This curve also forms the axis of a narrow band within which the shock was continuous, the two series of vibrations being felt simultaneously.

The only conclusion that can be drawn from these observations is that the seismic focus consisted of two detached portions. One of these, the more important, was evidently in the neighbourhood of Hereford, its

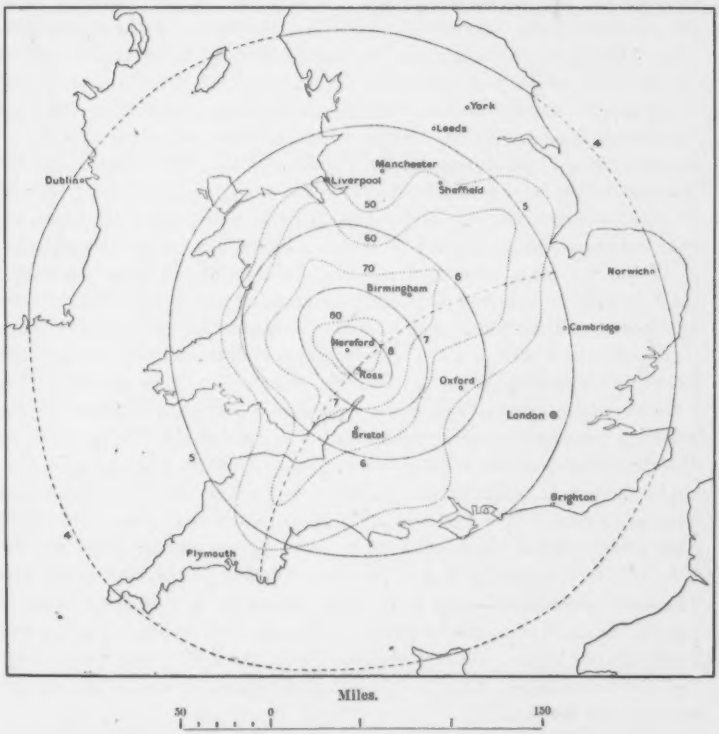

FIG. 5.—HEREFORD EARTHQUAKE OF DECEMBER 17, 1896.

centre being about 3 miles south-east of that city; the other was probably about 2 or 3 miles north-east of Ross, the distance between the centres of the two foci being about 9 miles. As the surface-band within which the two parts of the shock coalesced is concave to the south-east, it follows that the Hereford focus was first in action, as the vibrations from it had to travel farther than those from the Ross focus before coalescing with them. Also, since the two series of vibrations were superposed at places within the curved band, it is clear that the Ross

focus was in action before the vibrations from the Hereford focus had time to reach it—otherwise, the latter vibrations would have been felt everywhere before the former. Thus, though due to a single generative effort, the impulses in the two foci occurred independently and almost simultaneously, the interval between them being not more than 2 or 3 seconds. On this account the Hereford earthquake belongs to the class which I have called twin earthquakes.

These conclusions are confirmed in a remarkable manner by the observations on the sound-phenomena. Within the whole disturbed area 59 per cent. of the observers recorded their perception of the earthquake-sound, the percentages of audibility varying from 87 in the central county of Hereford to 23 in Essex. The audibility of the sound did not, however, depend entirely on the distance from the centre, as will be seen from the dotted lines on the map, which represent isacoustic lines corresponding to audibility-percentages of 80, 70, 60, and 50. The distortion of the isacoustic lines in the neighbourhood of the curved band is clearly due to the coalescence of the sound-vibrations from the two parts of the focus, the effect of the coalescence being obviously a higher percentage of audibility.

From the orientation and relative positions of the inner isoseismal lines it may be inferred that the originating fault runs approximately north-west and south-east, and hades to the south-east, and that the fault-line must pass a mile or less to the south-west of Hereford. Now to the north-east of this position lies the well-known Woolhope anticlinal the axis of which runs about north-west and south-east. Moreover the thinning out and occasional disappearance of some of the Silurian beds on the south-west side of the anticlinal suggests that there must be a fault or rapid flexure at or near the junction of the Old Red Sandstone and Silurian strata. If a fault, it must hade to the north-east. It would thus satisfy two of the conditions required by the seismic evidence, but the fault-line would lie a mile or two to the north-east. Thus the Hereford earthquake must have been caused by a movement along a parallel fault lying a mile or two to the south-west, or possibly along the fault referred to, but at a considerable depth, the fault-plane assigned by the seismic evidence being a tangent-plane to the fault-surface at the depth of the focus.

4. *Derby Earthquake of March* 24, 1903.—The isoseismal lines of this earthquake (corresponding to intensities 7, 6, 5, and 4) are represented by the continuous lines in Fig. 6. The disturbed area contains about 12,000 square miles. The inner isoseismal (intensity 7) is 38 miles long and 28 miles wide; its longer axis is directed N. 33° E., and the distance between the isoseismals 7 and 6 is 12 miles on the north-west side, and 8 miles on the south-east side. The originating fault must therefore run in a direction about N. 33° E., must hade to the north-west, and must pass a short distance to the south-east of Ashbourne. There is no known fault in this position.

As in the Hereford earthquake the shock consisted of two distinct parts, nearly equal in intensity and separated by an interval of three seconds of rest. The double shock was noticed in all parts of the disturbed area, except within a narrow rectilinear band, the boundaries of which are represented by broken lines on the map. This band, which is about 5 miles wide, runs centrally across the inner isoseismals in a direction at right angles to the axes of those isoseismals.

It is evident that the double shock was due to two distinct impulses

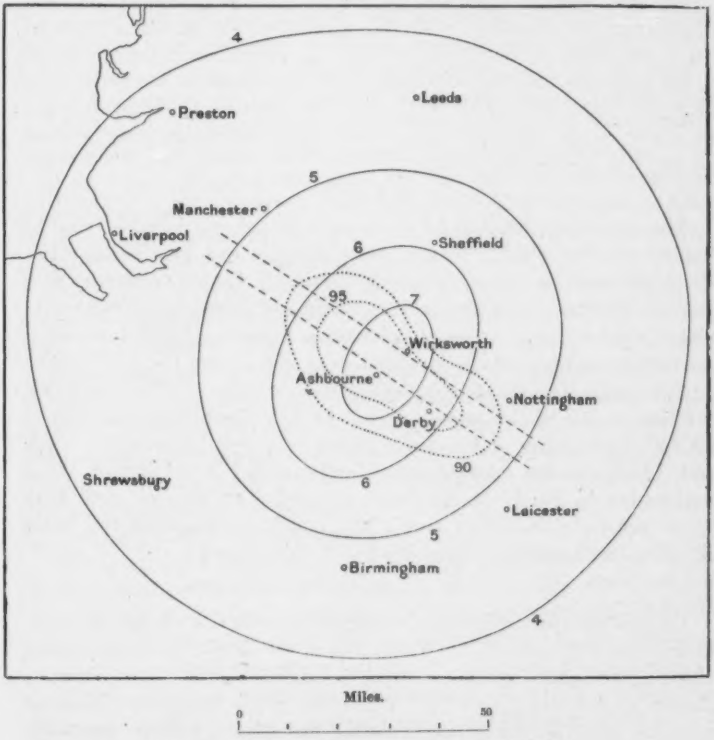

FIG. 6.—DERBY EARTHQUAKE OF MARCH 24, 1903.

occurring in detached foci arranged along a line parallel, or nearly so, to the isoseismal axes; that the two impulses were nearly equal in intensity; and that, as shown by the straightness and central position of the single-shock band, the two impulses occurred at exactly the same instant. The positions of the two epicentres cannot be determined exactly, but from the form of the isoseismal lines it is probable that one lay close to Ashbourne, and the other about 3 miles west of Wirksworth. The distance between the centres of the two foci must therefore be about 8 or 9 miles.

These conclusions are again supported by the evidence of the isacoustic lines corresponding to audibility-percentages of 95 and 90. As will be seen from the dotted lines on the map both curves are distorted in the direction of the rectilinear band, their axes being almost coincident with this band.

The principal earthquake was followed by three after-shocks, the first two of which were extremely slight, and took place on the same day. The third occurred on May 3, the shock being of intensity 5. The disturbed area contains about 585 square miles. The isoseismal lines are ellipses roughly concentric with and parallel to the isoseismal 7, their longer axes being in the direction N. 25° E. From the relative position of the isoseismal lines the originating fault must hade to the north-west. There can therefore be little doubt that the after-shock originated in the same fault as the principal earthquake, and in the region lying between the two foci of that earthquake.

Classification of British Earthquakes.

The preceding descriptions show that British earthquakes may be divided into two distinct classes, namely simple and twin earthquakes. Simple earthquakes consist of a single series of vibrations, usually with one, but sometimes with two or more maxima of intensity. Twin earthquakes consist of two series of vibrations, separated by an interval of two or three seconds, which is generally one of complete rest and quiet.

The modes of origin of simple and twin earthquakes will be considered in a later section of this paper. It will be sufficient to state here that of the 357 earthquakes of the period considered, only 11, or about 3 per cent. belong to the class of twin earthquakes. Also that of the 9 earthquakes in which the isoseismal 4 included an area of more than 10,000 square miles, 2 were simple and 7 twin earthquakes, the latter including the strongest earthquakes felt in this country.

Distribution of British Earthquakes.

Of the 357 earthquakes felt during the years 1889 to 1914, 51 occurred in England, 27 in Wales, 279 in Scotland. In Ireland not a single earthquake is known to have originated, though 5 Welsh or English earthquakes were felt across the Irish Channel. Thus as regards number only Scotland holds the first place; and the inequality is still greater if the area of the countries be taken into account, as then for every 10 earthquakes occurring in England, there are 37 in Wales, and 94 in Scotland. If, however, the intensity of the strongest earthquakes be considered the inequality is reversed. Thus of the 9 earthquakes in which the isoseismal 4 included an area exceeding 10,000 square miles, only 1 occurred in Scotland, while 4 occurred in England and 4 in Wales. Again, while in the Inverness earthquake of 1901 this area amounted to 33,000 square miles, in the Pembroke earthquake of 1893 it amounted to 35,900 square miles, in the Swansea earthquake

of 1906 to 37,800 square miles, in the Pembroke earthquake of 1892 to 44,860 square miles, and in the Hereford earthquake of 1896 to 98,000 square miles.

The earthquakes of Scotland are remarkable in other respects besides frequency. They are invariably simple earthquakes, twin earthquakes being confined to England and the south of Wales. The great majority can be assigned with some degree of confidence to well-known faults. And lastly, these faults belong for the most part to one system of fractures: that to which the name Caledonian is usually applied, the direction of which is roughly north-west and south-east For instance, the northern boundary-fault of the Highland district, which traverses Scotland in a south-westerly direction from Tarbet Ness through Inverness, is connected with 17 of the 19 Inverness earthquakes of 1901, with some, if not all, of the 11 Inverness earthquakes of 1890, and possibly with 5 slight earthquakes in the neighbourhood of Fort William. The southern boundary-fault of the same district, which traverses Scotland from Stonehaven to the southern end of Loch Lomond, is responsible for the three Comrie earthquakes; and the fault which skirts the southern slope of the Ochil Hills (though trending more in an easterly direction) with 186 shocks. Again, the two Edinburgh earthquakes of 1889, the Kintyre earthquakes of 1889 and 1890, the Strontian earthquake of 1902, and the Dunoon earthquakes of 1904 and 1908, are connected with faults which run roughly in a north-easterly direction. The faults to which the 41 Glen Garry earthquakes of 1889–1899 and the three Annandale earthquakes of 1894 and 1896 are to be assigned are unknown, owing to insufficient records. The only known exceptions are the Loch Broom earthquake of 1892, which was due to a movement along a fault directed N. 30° W., and the two Glasgow earthquakes of 1910 caused by movements along a fault running nearly east and west.

In Wales slight shocks are rare unless they occur as accessory shocks of strong earthquakes, the only exceptions being the Bala earthquake of 1903 and the Beddgelert earthquake of 1904. The origin of the latter earthquake is unknown, as are also the origins of five of the Pembroke earthquakes of 1892. Of the remainder the principal Pembroke earthquake of 1892 and at least three of its after-shocks were connected with Malvernian faults, having a general north and south direction; two of the after-shocks of that earthquake, as well as the strong Swansea earthquake of 1906 and its after shock of 1907, and probably the four Pembroke earthquakes of 1893, with Armorican faults, having a general east and west direction. The eight Carnarvon earthquakes of 1903 and 1906 are associated with the Aber-Dinlle fault, and the Bala earthquake of 1903 with the great Bala fault, both faults belonging to the Caledonian system. In the Welsh earthquakes of 1889–1914, the Charnian system of faults (north-westerly in direction) is entirely unrepresented.

In England the epicentres are somewhat widely distributed; 13 lie

in Herefordshire (all connected with one fault), 10 in Cornwall, 8 in Derbyshire (connected with one fault), 5 in Yorkshire, 4 in Cumberland, 3 in Leicestershire and Somerset, and 1 in Devon, Lancashire, Worcestershire and Westmorland. The Californian system of faults is responsible for 15 earthquakes, the Charnian for 21, the Malvernian for 7, and the Armorican for 5. Seventeen faults (nearly all in Palæozoic rocks) have been in action, 12 with simple earthquakes, and 5 with twin earthquakes. Of these faults only three have been recognized by geological evidence, two being connected with simple earthquakes, and one with twin earthquakes.

Origin of British Earthquakes.

The close connection between the earthquakes and faults of Great Britain will be obvious from the preceding pages. It is not in all cases possible to associate particular earthquakes with well-known faults. This is only to be expected, seeing that the faults with which we are acquainted by geological evidence are those which traverse the superficial rocks. The investigation of earthquakes, indeed, throws light on the structure of portions of the earth's crust which are far below the regions that are accessible to the field-geologist; and it seems to indicate that the structure of these deeper layers is much less complex than that of the surface strata.

Into the nature of the connection between the earthquakes and the originating faults it is hardly necessary to enter. The subject is fully discussed in my little volume on the 'Origin of Earthquakes' (Cambridge Manuals of Science and Literature). But it may be remarked that all the faults with which British earthquakes have been associated are faults of great antiquity, and that the earthquakes can only be due to the *growth* of those faults, that is, to fault-slips by which the throw of the fault is changed. The friction which results as one rock-mass slides over and grates against the other is the originating impulse of the earthquakes.

In simple earthquakes the fault-displacement is of the simplest possible character. One rock-mass is displaced relatively to the other over a continuous area which is several or many miles long in a horizontal direction. This area constitutes the seismic focus. The amount of displacement may not, in any part of the focus, exceed a fraction of an inch, and it dies out both upwards and laterally. The result of this displacement is a sudden increase of strain in the marginal regions of the focus and in the portion of the fault immediately above the focus. And this increase of strain may be, and often is, sufficient to precipitate minor slips, each of which gives rise to an after-shock. Thus, as in the case of the Inverness earthquake of 1901, the after-slips should take place especially towards the terminal regions and in the portion of the fault above the central region of the principal focus. Each minor slip, however, increases the strain to a similar, but less, extent in its surrounding regions. Thus there may be a continual migration of the seismic

foci until the increased resulting strains are insufficient to overcome their resistances opposed to them. The series of earthquakes then comes to an end, and a state of quiescence ensues, which lasts until the growing strains are once more great enough to precipitate movement.

Twin earthquakes, as we have seen, are due to slips within two detached foci. The two slips are so nearly simultaneous that they must be regarded as independent, that is, one is not a consequence of the other. At the same time, both slips must be due to a single generative effort, for it is inconceivable that two independent slips should occur so closely together as regards both time and space. Simple displacements being thus out of the question, the only other movement that can account for twin earthquakes is one of rotation; and, in the formation of crust-folds, and especially along their intersection by transverse faults, it is evident that such movements must be taking place. For instance, in Fig. 7 the

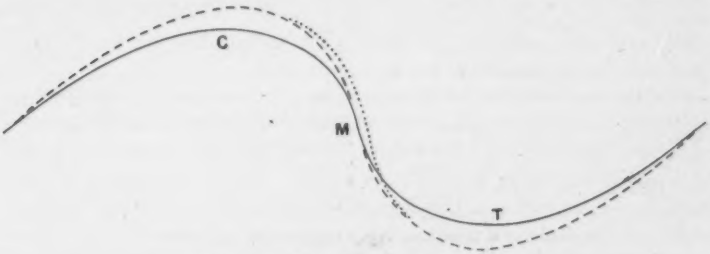

FIG. 7.—ORIGIN OF TWIN EARTHQUAKES.

continuous line is supposed to represent a stratum of a crust-fold, of which C is the crest, T the trough, and M the middle limb. The broken-line represents the same stratum after a step in the growth of the fold. The result of such a movement will clearly be displacements, nearly or quite simultaneous, in two detached foci C and T, with an intermediate region of little or no displacement in that portion of the middle limb M about which rotation has taken place.

After the occurrence of such a twin-displacement the strains along the margins of both foci are immediately increased, especially in the interfocal region of the middle limb. In consequence of this increased strain twin earthquakes are usually succeeded, after a few hours or days, by an after-shock originating in the interfocal region; and, as these after-shocks are always simple earthquakes, it follows that they are caused by simple displacements, without rotation, of the middle limb, say from the position represented by the broken-line in Fig. 7 to that represented by the dotted line. But since the after-shock is always weaker than the twin earthquake, it is clear that the translation of the middle limb is much less in amount than the previous displacements of the crest and trough. Thus the movements which cause a twin earthquake and its successor result

(1) in accentuating the form of the crust-fold, and (2) in a relative advance of one portion of the crust-fold cut off by the transverse fault.

If this theory of the origin of twin earthquakes be correct there should be some correspondence between the distance between the epicentres of the earthquakes and the distance between successive crests and troughs of the great crust-folds. For British crust-folds this distance is unknown; but for the principal folds in France the average distance in different districts varies between 9 and 12 miles. As the average distance between the epicentres of British twin earthquakes is about 10 or 11 miles, the agreement is sufficiently close.

Between simple and twin earthquakes there is thus an important difference, not only as regards their nature but also as regards their origin. Also to this difference in their origin there corresponds a difference in the nature of the fault to the growth of which they are due. Leaving out of account the after-shocks of twin earthquakes, it would seem that simple earthquakes are usually, almost invariably, due to displacements along strike-faults, while twin earthquakes are due to displacements along transverse faults.

Lastly simple earthquakes can usually be referred to well-known faults; in twin earthquakes the originating fault is almost invariably unknown, though in some cases the direction and hade agree with those of neighbouring faults, but differ by a mile or two in the position of the fault-line. The reason of this difference is probably that simple faulting along a strike-fault is a comparatively superficial phenomenon, while the growth of a fold along a transverse fault is much more deeply seated. In the latter case the fault-surface determined by the seismic evidence is, strictly speaking, a tangent-plane to the fault at a considerable depth, and this tangent-plane does not of necessity intersect the surface of the earth along the same line as the superficial portion of the fault-surface which is known to geologists.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE meeting of the British Association at Manchester this year differed, as was indeed fitting, from previous meetings of the Association. The proceedings, instead of lasting for a week as is the custom under normal conditions, began on Tuesday, September 7, and in most sections were concluded on the following Friday. As social functions, however, were practically in abeyance more time was available for scientific work, and in Section E at least the time devoted to papers and discussions was not appreciably less than in former years. The meeting was not a large one (1400 members and associates as against 3800 when the Association last met in Manchester in 1887), but its success from the scientific point of view has led to the suggestion that the Association should revert to its earlier practice and abandoning all social activities should confine itself to purely scientific work.

In one respect Section E suffered as a result of the war. Its President, Major H. G. Lyons, F.R.S., was prevented from attending by pressure of Government

work; and two of its vice-presidents, Sir Charles Lucas, K.C.B., and Prof. H. N. Dickson, were also detained in London by matters arising from the war. In these circumstances the Section was fortunate in having as its remaining vice-Presidents Mr. G. G. Chisholm, Prof. J. W. Gregory, Mr. Harry Nuttall, M.P., and Mr. H. Yule Oldham, who undertook to preside in turn at committee and sectional meetings. Mr. J. McFarlane acted as Recorder, and Dr. R. N. Rudmose Brown as secretary.

The business of the Section began on Wednesday morning with a note by **Mr. A. R. Hinks** on some questions connected with the **Map on the scale of 1/M,** compiled at the Royal Geographical Society under the direction of the General Staff. After pointing out that the map must not be considered as in any way competing with the *Carte Internationale du Monde au Millionième*, but as a rapid production inspired by the necessities of the present situation, Mr. Hinks discussed briefly the importance of the indexes to boundaries as a means of relieving the body of the map of spaced-out regional names; and at more length the colour scheme suited for representation of great relief on the scale of 1/M. He exhibited the experimental series of sheets produced two years ago by the Survey of India, which provide the most instructive material for discussion, and he gave reasons for preferring the hill-shaded sheet with both glaciers and snowfields shown, the former by blue glacier lines, and the latter by bluish-grey shade. (This set of experimental sheets may be seen in the Map Room of the Society.)

Mr. B. C. Wallis followed with an interesting paper on **"Methods of Representing the distribution of Population on Maps,"** and more especially upon the 1/1,000,000 map. On the Buda-Pest sheet of this map he had inserted the density of population in each administrative area as if it were a spot height at the centre of the area, and had then drawn contours of equal density. In this way the gradation of density is suggested in a more continuous fashion than by the ordinary method; and abrupt changes and sharp angles tend to disappear. Mr. Wallis also discussed methods of representing the racial distribution of the population. One copy of the Buda-Pest sheet showed the more important ethnical groups as percentages of the total population by the method adopted for the density map; while on another copy the complete facts were shown numerically. Mr. Wallis's map attracted considerable interest.

The **Presidential Address,** which had been delayed at the request of Section C in order to permit some of their members to be present, was then read by Mr. Yule Oldham. The address, which dealt with the necessity for research in Geography, was published in the October number of the *Journal*. On the motion of Mr. H. Nuttall, M.P., who presided, it was resolved that the thanks of the Section should be conveyed to Major Lyons.

The afternoon session was devoted to a series of short papers by members of the Section who had been present at the Australian meeting. **Mr. O. J. R. Howarth** showed three **Vegetation Maps of Australia** drawn on the same scale and coloured according to the same scheme, which he had enlarged from small maps taken respectively from a standard authoritative work on plant geography, a well-known school-book, and a well-known atlas. Mr. Howarth pointed out various respects in which the maps differed from one another, and suggested that when a suitable opportunity presented itself a small committee should be appointed to undertake the scrutiny and criticism of existing material for the compilation of certain classes of distribution maps. Such a committee might well begin its work upon the data available for vegetation maps of Australia.

Professor J. W. Gregory followed with a paper on the **"Relations of the Central Lakes of Westralia."** These dry lake-basins have been represented as

hollows due to deflation by wind, to corrasion by ice, or to the action of a former sea. Professor Gregory believes that they are basins left by the dismemberment of a Miocene river system. In 1914 he published a sketch-map which showed the drainage from Lakes Giles, Barlee, and Ballard, passing through Lake Raeside south-eastward to the sea which probably at that time extended over the Nullabor Plains. The recent issue of the southern sheet of a contour map of Western Australia shows that the above-mentioned lakes are connected by land below the level of 1250 feet, and that the only outlet from that many-branched depression is south-west through Lake Deborah to the Swan River. Professor Gregory is still of the opinion that the original drainage was towards the south-west, and thinks that if the existence of the outlet from Lake Ballard through Lake Deborah be confirmed, the channel was probably of later date and was formed as a result of the blocking up of the south-eastern outlet by wind-borne drifts.

Mr. J. McFarlane then gave an account of **The Burrinjuck Dam and the Murrumbidgee Irrigation Area.** After describing the position and functions of the dam he proceeded to discuss the influence of the introduction of an irrigation system upon human activities in the irrigated area. Political, social, and economic conditions had all been profoundly modified. The administrative power had been strengthened; the return from the land had been altered in character and greatly augmented in value; the population had increased and townships had been established.

On Thursday morning **Dr. J. D. Falconer** opened a joint discussion with Section C on **The Classification of Land Forms.** Dr. Falconer said that hitherto the treatment of land-forms had been subsidiary to the discussion of processes, and offered no clue to the scientific definition and classification of individual forms. He believed, however, that these would submit themselves to systematic classification with almost as much ease as the subject-matter of other sciences, and that it fell within the scope of geography as the science of the Earth's surface to establish such a classification. He accordingly proposed to set up two classes of land-forms, each containing two orders:

Class A. Endogenetic Forms.
- Order I. Negative Forms.
- Order II. Positive Forms.

Class B. Exogenetic Forms.
- Order I. Degradation Forms.
- Order II. Aggradation Forms.

The two orders of endogenetic forms are then subdivided into four families:

Family 1. Forms due to superficial volcanic activity.
2. „ „ sub-crustal volcanic activity.
3. „ „ radial movements.
4. „ „ tangential movements.

Similarly the two orders of exogenetic movements are each subdivided into nine families.

Family 1. Forms due to the action of the run-off.
2. „ „ „ percolating water.
3. „ „ „ streams and rivers.
4. „ „ „ life.
5. „ „ „ lightning.
6. „ „ „ sun-heat.
7. „ „ „ the atmosphere.
8. „ „ „ frozen water.
9. „ „ „ the sea.

Each family is then subdivided into genera or specific forms. He suggested that a land-form be defined as any surface or slope which may be referred in origin to the operation of a single process or force. Monodynamic surfaces of this kind being rare, however, the commoner polydynamic surfaces would be classified according to the predominant forces among those responsible for the production of the surface.

In the discussion which followed, Prof. Gregory said that the initial difficulty was that different classifications were required in Geography and in Geology. Dr. Falconer restricted the term "land-form" to what may be called the simple land-forms, whereas the term was originally used for the greater features which may be called compound land-forms. The geographer required a classification based on form rather than on origin, and used such familiar terms as mountain and valley, with whose help he could not afford to dispense. In conclusion Prof. Gregory thought that Dr. Falconer's classification would be of value as a complete systematic tabulation of the land-forming processes, while his primary division into endogenetic and exogenetic forms showed the increasing recognition of the view that the major relief of the Earth is due to crustal movements.

Prof. Grenville Cole thought that a systematic classification of land-forms might tend to check the descriptive faculty of the teacher of geography. Brief but comprehensive description, in language familiar to the reader or hearer, was needed to bring home the relation of a group of surface-features to man's life among them. It was the privilege of the geographer to deal with the reaction of the Earth on its inhabitants and to show how our surroundings were the result of a long and often complex series of processes. Close definition, especially in the Greek language, might tend to obscure the beauty of a landscape; but a description in the familiar tongue, like that given of the Roman area by Prof. W. M. Davis, may be in itself so beautiful, and beautiful by its impressive accuracy, that the student of land-forms and human movements received something that is unforgettable, without being weighed down by any new burden of terminology. Geography should be carefully maintained as the fundamental and most appealing scientific subject both in primary and higher education for the millions who are called upon to play their part in an imperial commonwealth.

Mr. Chisholm said that he was gratified to observe that the geologists who had spoken recognized (though not fully and consistently) what he thought the distinctive aim for Geography, namely, the study of the influences of terrestrial local conditions and place relations. For this of course description was necessary, but he failed to see the utility for geographical description of the subdivisions of simple land-forms proposed by Dr. Falconer.

Dr. Hickling emphasized the point raised by Prof. Gregory that the description of the great features of the Earth's surface should be kept separate from that of the minor features; and this not only for the purpose of giving clear conceptions, but also because these two types of features are almost wholly distinct in origin, the former being essentially the result of crustal movements, while the latter are nearly all the result of the varied processes of denudation, direct or indirect.

A joint discussion with Section H on **Racial Distribution in the Balkans** was then opened by **Prof. Elliot Smith,** who dealt first with the geographical factors which have affected the history of the Balkan peninsula. That peninsula has no natural boundaries as the Italian peninsula has, and it has always offered free means of ingress from the north. This circumstance is accountable for the fact that from the earliest times there have been constant streams of incoming races, and for this reason alone the peninsula has continuously been in a state of disturbance. It also borders upon seas which have always been centres of great

activity; it has been the natural meeting-place of Asiatics and Europeans passing from one continent to the other; and it was interposed between Rome and Byzantium. This condition of being placed between conflicting interests and rival empires had its beginning before the Christian era. The region was in a state of disturbance long before the Turk came to it, and when he is gone many of the problems that have agitated the Balkans will remain. Prof. Elliot Smith then proceeded to explain the successive intrusions of peoples into the Balkan peninsula. The aboriginal population was of the Mediterranean race—the small, dark-haired, long-headed type of the Mediterranean littoral. It was affected by successive intrusions of the Alpine races, broad-skulled, thick-set people of medium colouring who stretched all along the Alpine system of Europe and Asia, and by invasions of blends which had been mixed from Nordic, Mongolian and Alpine elements at the headwaters of the Yenisei. These were respectively the Slav and the Bulgar intrusions—the Slav from the area between the Vistula and the Volga; the Bulgar in the eighth century breaking off from a Turki branch of the same origin and travelling towards the Balkans by a northern, while the Turki travelled by a southern, route. With regard to existing conditions Prof. Elliot Smith pointed out that the population of Macedonia was extremely mixed. Serbian, Bulgarian, Greek and Rumanian elements were all found in it, but in his opinion it was more nearly allied to the Bulgarian race as a whole than to the southern group of Slavs. The Albanians again were part of the original Slav population, and no more closely connected with the Greeks than with the Slavs. The Dalmatian coast, with the exception of Istria, was also predominantly Slav.

Sir Arthur Evans then showed an **Ethnographical map** of the peninsula which he had compiled. He considered that the whole of Macedonia, with the exception of the Greek coast and one other part, was almost homogeneously Bulgarian.

At the afternoon session **Mr. P. M. Roxby** gave an account of the visit he had paid while an A.K. Fellow to **North China and Korea.** He dealt first with various aspects of Chinese and Korean life, which he illustrated by an exceptionally fine series of lantern slides, and then discussed the geographical factors affecting the economic and political development of North China, Manchuria, and Korea, with special reference to the railway situation, the relations of China to Russia and Japan, China's interest in the European war, and the work of the Japanese in Korea. He laid special emphasis on the fact that the three peninsulas of the north—Shantung, Liaotung and Korea—which contained all the good harbours, had now fallen to a greater or less extent under the control of Japan.

Dr. R. N. Rudmose Brown then read a paper on **Spitsbergen,** in which he embodied an account of the expedition made there by Dr. W. S. Bruce in 1914. It will be remembered that last year the British Association made a grant towards the cost of this expedition. The chief points dealt with by Dr. Rudmose Brown will be found at somewhat greater length in his paper on Spitsbergen in the July number of the *Journal*.

Prof. Gregory presided on Friday morning, and, on taking the chair, referred to the great loss which geography had sustained by the death of Prof. Herbertson, a former President of the Section.

The **Rev. W. J. Barton** then presented the report of the committee appointed to inquire into the choice and style of **Atlas, textual and wall maps** for school and university use. The report, which had obviously been carefully considered, deals with the maps which it is desirable to have in junior and senior school atlases, their style, draughtsmanship and lettering, the projections on which they ought to be constructed, and the conventional signs to be employed. The whole report is of

considerable value, and should be carefully studied by all who are engaged in the publication of school atlases and wall-maps. On one point only was there criticism. The report advocated the exclusion of Mercator's projection from the body of the atlas, a step which Mr. Yule Oldham thought too drastic as he considered Mercator's map well adapted for certain purposes, as for example for showing the distribution of temperature. Mr. Barton in replying to this criticism indicated that the committee considered that, for distribution maps, hemispheres are very much to be preferred to either Mollweide's or Mercator's; but that if any one should wish to retain a cylindrical projection of some kind, then there were others, such as that of Gall, more suitable than Mercator's for use in economic atlases. The committee were unable to make any recommendation with reference to an atlas for university use, "feeling that a university student should have access to and familiarity with a wider variety of maps than could be included in one volume."

A paper on the **"Distribution of Population in the District round Leek"** was then read by **Mr. Raymond Curtis.** In it he discussed the influence of agricultural and industrial development, past and present, upon the relative density of population in different parts of the area. Of particular interest was his examination for the evolution of market towns in the agricultural districts. A village-nucleus of farmhouses arose at various places throughout the area wherever considerations of defence, ease of communications, water-supply, etc., led to a grouping together of habitations. The subsequent growth and development of this village-nucleus depended mainly upon two factors—the area and the productivity of which it was the focus. The stages of growth may be conveniently classified as the "inn-village" (*e.g.* Gradbach, Heaton and Bottomhouse), the "shop-village" (*e.g.* Meerbrook and Grindon), the "fair-village" (*e.g.* Hartington and Flash), and last, the "market town" (*e.g.* Leek, Cheadle and Longnor). For various reasons, but mainly through the development of communications, Leek now dominates the whole area.

"The Middle Tees and its Tributaries" was the title of a paper by **Mr. C. B. Fawcett,** in which he considered the middle portion of the Tees and its tributaries from Stainmore to the eastern edge of the Carboniferous rocks of the Pennines. The district which they drain is characterized by three distinct types of topography: (i.) a wide and comparatively smooth upland surface, sloping gently eastward, but cut off abruptly to the west of the Pennine Scar, with a few hills rising above it; (ii.) a series of wide, shallow, mature valleys; (iii.) a series of narrow and youthful valleys, which are for the most part sunk below the floors of the mature valleys. After considering in detail the course of the Tees, the Preta, the Balder, and the Langley, Mr. Fawcett concluded that the river system is the product of at least three distinct cycles of erosion:

(i.) The comparatively smooth surface of the upland is part of a peneplain. If its valleys were filled up it would be a plain sloping gently eastwards with its surface cutting across the rock strata at a small angle. The formation of this peneplain probably occurred during the Tertiary era.

(ii.) The wide, shallow, mature valleys mark the second cycle. Their shallowness indicates that the change of base-level which caused their formation was small; and their relation to the glacial drift and the route of the ice indicates that they had reached their full development before the Ice Age. The elevation which led to their formation probably occurred in the latter part of Tertiary time. The main consequent valleys are all of this type: and the more important subsequent valleys are also pre-glacial, though somewhat younger.

(iii.) The deep and narrow gorges in which many of the streams flow are the product of the last cycle of development, which is still in a very youthful stage. Its

initiative was due to a post-glacial uplift of the region. A typical tributary valley consists of three clearly marked sections: (i.) the upper course on the upland with a very slight valley; (ii.) a broad and shallow valley on the floor of which the stream meanders; (iii.) a gorge in the bottom of this wide valley in which the stream rushes along over a series of rapids.

Professor H. J. Fleure, in a paper on the **"Distribution and Movements of Population in South Britain,"** drew attention to some factors which he thought had been insufficiently appreciated. He showed a map of Britain in which all the regions occupied, so far as is known, in Neolithic times were marked. These included the Chalk Downs, the moorlands of south-west England, the Cotswold top, a few patches, especially near Birmingham, in the midlands, some valleys in the East Anglia chalk, as well as a few chalk ridges, *e.g.* above the fen edge, the Pennines, York moors and wolds, moorland tops in South Wales, and Denbighshire moorlands. Their inhabitants were the dark-haired, long-headed Neolithic folk now found in large numbers in the valleys around the ancient uplands, save that they have been nearly washed out around the Chalk in the south, which lies on the track of many invasions. The valleyward movement of peoples in Britain is therefore of great importance, and evidence was given of its various stages, still in progress and of sociological importance at the present time. The other factor emphasized was the route across the Channel, in addition to that by the Straits of Dover, from Barfleur to St. Catherine's Point, whence one may coast or cut across the Chalk Downs and so get to South Wales and the Irish Sea. This is to be understood as part of a point-to-point route from the Mediterranean *viâ* the Irish Sea to Norway. The importance of this route in mediæval times, in pre-Roman times, in the Bronze Age, and at the time of Dolmen building was discussed, and reference was made to the dark broad-headed men found in patches along it.

The proceedings of the Section concluded on Friday afternoon, when **Professor Patrick Geddes** discussed the **Growth of Cities.** The historic interpretation of cities was of particular importance at the present time, as the study of cities, and of the successful metropolis above all, was a much more realistic way of viewing the state than as a philosophic abstraction. We were at war not so much with Germany, or even Prussia, as with Berlin, a vast artificial construction which for a generation or more had kept pace with the growth of Chicago without Chicago's natural resources. As Berlin has conquered Germany so France is too much the conquered country of Paris, and so in many respects England is the conquered country of London. At the conclusion of his paper Professor Geddes conducted a number of his audience to an exhibition, which he had arranged with Miss Barker, of maps, pictures, books, and broad sheets illustrating the war. The special object of this exhibition is the study of the war graphically, and both from an historical and a geographical point of view. An exhibition of regional surveys, which were explained by Miss Barker, also attracted considerable attention.

J. McF.

WATER SUPPLY AND IRRIGATION IN AUSTRALIA.

No question, perhaps, is engaging more attention in Australia than that of the extension of settlement and agriculture in the drier regions by means of irrigation, whether from artesian wells or from reservoirs formed by the building of dams across the rivers. It will be remembered that the question of the development of the artesian system in the great interior basin was the subject of a paper read before the Society in 1902 by Mr. W. G. Cox, C.E., who, while emphasizing the great importance to Australia of its underground water supply (which he considered

to have its origin in the rainfall over the elevated margin of the basin), took a sanguine view of the amount of water available, treating it as practically inexhaustible. Some of his hearers may have felt that without a more careful study of the factors involved, particularly the rainfall over the intake area, it was doubtful to what extent the artesian development could proceed without depletion of the supply stored in the pervious strata, though it was allowed that this might not take place for many years to come. Since that date the boring of wells and the study of the subject have proceeded continuously, and an attempt to take stock of the present position of the question may therefore be opportune. We are indebted to Mr. Cox for a statement of the position as it is understood by those most qualified to judge on the spot, and this has been used in the preparation of the following summary. Further aid towards an understanding of the question is supplied by a paper by Mr. E. F. Pittman, Government Geologist of New South Wales, prepared last year for the Sydney meeting of the British Association, and issued by the Geological Survey of New South Wales under the title "The Great Australian Artesian Basin and the Source of its Water."

The practical importance of a knowledge of the source of the artesian water is evident from the fact that the fears of those who looked forward to a possible diminution of the supply with increased use have already proved to be in some degree justified, recent investigations having shown that a diminution of flow from the wells in use has set in, officially estimated last year at eight per cent. per annum in Queensland and New South Wales. It is perhaps unfortunate that this question of the source of the water should have given rise to somewhat heated controversy. It has been generally accepted by Australian hydrologists that, as in the case of artesian basins generally, the supply is derived from the rain and river water absorbed by the porous strata outcropping at a higher altitude on the edge of the basin—in this case along the elevated zone to the east—the pressure being purely hydraulic, due to the action of gravity. This view was upheld in 1901 by Mr. Pittman in a paper dealing with the New South Wales portion of the artesian basin. But in his book, 'The Dead Heart of Australia,' published in 1906, Prof. J. W. Gregory put forward the theory that the water supplied to the bores was not of recent atmospheric but in great part of plutonic origin, and had not previously appeared above the surface at all. In his paper published in this *Journal* for July and August, 1911 ("The Flowing Wells of Central Australia") he further developed his views, replying to criticisms that had appeared meanwhile. Mr. Pittman's paper of 1914 is a detailed reply to Prof. Gregory, based on facts and statistics which in his view entirely disprove the latter's theory, or at least show that it is without adequate foundation, while all the facts fit in with the opposite view. Without venturing to pronounce an opinion on the merits of the controversy, we may briefly summarize Mr. Pittman's main objections to Prof. Gregory's theory, and his arguments for an atmospheric origin of the water.

One of the points on which Prof. Gregory laid special stress was the oscillation of level in the Urisino well, which from published accounts he supposed to be regular and rhythmical, of the nature of geyser action. But none of the previous writers had spoken from personal knowledge, and Mr. Pittman's examination of the well has shown that the above assumption is quite incorrect. The water rises and falls to a varying extent, and with very varying periods; its motion is not turbulent or intermittent, so as to suggest geyser action, but so gradual and gentle as to be practically imperceptible. Its cause is obscure, but no just conclusions can be drawn from the erroneous information used by the first writers. Another argument depends on the relation between rainfall and run-off in the basin of the Darling. Supporters of the rainfall theory have held that the small proportion

of the rainfall ultimately discharged by the river proves the extent of absorption by the porous formations traversed by it. Prof. Gregory denied that the run-off of the Darling was relatively much less than that of the Murray, but Mr. Pittman quotes official statistics showing that in a nine-year period the Murray at Wentworth discharged 5·6 per cent. of the rainfall over its catchment area, while the Darling at the same point discharged only 0·54 per cent.—the mean temperature, and therefore the probable loss by evaporation, being about the same over the two areas. As regards the extent and location of the porous strata serving as the probable intake of the water, Mr. Pittman once more insists on the importance of the extensive Trias-Jura sandstones, though these equally with the "Blythesdale Braystone," of Lower Cretaceous age, were held by Prof. Gregory to be incapable of absorbing any large volume. Recent geological surveys have, Mr. Pittman holds, confirmed his belief in the *rôle* played by the former, first enunciated in 1895.

In regard to Prof. Gregory's arguments from the limitations of water-pressure, the irregularities in the potential level of the water, and the supposed discontinuity of the water-bearing stratum, Mr. Pittman avers that he has in many ways misapprehended the facts or principles in question. The former suggested as a cause of high potential in certain areas the occurrence there of volcanic activity in Tertiary times, and to this it is objected that in other sites of such activity there is no supply of water under high pressure, and that where there are more volcanic foci than in any other part of Queensland there is no artesian water at all. To Prof. Gregory's statement that in the Oxton Downs bore the water was obtained in granite (and therefore plutonic), it is replied that there is clear evidence that the water comes up through a *fissure* in the granite; whilst as regards the chemical composition of the water, and the supposed presence in certain wells of lithium or zinc, it is shown that the supposition is erroneous, except as regards a small amount of zinc derived from the galvanized iron pipes of the pumps.

Mr. Pittman concludes by pointing out that it is the unanimous opinion of those geologists who have had opportunities for a careful study of the artesian basin (including the Government geologists of Queensland, New South Wales, South and West Australia) that the water from the flowing wells is of atmospheric origin, and that hydraulic pressure is the primary cause of its rising above the surface. Water under such pressure, he states, is found nearly everywhere within a true geologic basin measuring nearly 1500 miles from north to south, with a maximum width of nearly 1000. Above the impermeable floor of the basin, and overlain in turn by an impermeable covering, are extensive beds of porous Mesozoic sandstones, with an outcrop on the eastern margin some 65 miles wide, and dipping west towards the centre of the basin. Their continuity for at least 400 miles in New South Wales has been proved by fossil evidence, and water under pressure within the basin is always associated with a porous sand-rock. The altitude of the outcrop reaches more than 2000 feet above sea-level, and is everywhere considerably greater than that of the plains where the flowing wells occur, or the height above sea-level to which the water will rise. The areas of porous outcrop have a mean annual rainfall of about 25 inches, and are traversed by all the tributaries of the Darling, which, as above stated, has a much lower run-off relative to the rainfall than the Murray with its basin of impervious rocks.* Such, in brief, is the view of the facts generally held by competent persons in Australia.

The above-mentioned diminution of the flow from the existing wells can hardly

* It may be doubted whether Mr. Pittman has taken sufficient account of the possible greater evaporation from the Darling basin, other factors than temperature alone having surely a bearing on the question.

be thought surprising in view of the constant activity maintained in boring for artesian water. Whereas the Queensland Government Report for 1901 stated that the aggregate depth bored in 891 flowing or non-flowing wells was 202·01 miles, by the end of April 1914 the total had reached 441·64 miles, of which over 24 miles had been bored in the previous ten months. In the same interval the estimated continuous yield has increased by over 50 per cent., the yearly amount from 977 flowing bores being now over 500,000,000 gallons per diem—sufficient to cover over 1000 sq. miles 1 foot deep. The last official report for New South Wales gives, as the total depth of 520 artesian and sub-artesian (non-flowing) bores, about 161½ miles, the total flow from the bores actually gauged being over 108,000,000 gallons per diem. Works are under construction in New South Wales for the distribution, by channelling, of water over an area of about a quarter of a million acres, about 4 million being already so served. As the appreciation in value of pastoral lands so provided with water is about 10s. per acre, the benefits already gained are apparent. In South, and also in West Australia (in the latter case from a distinct artesian basin), considerable progress has likewise been made. The proved artesian area within the great basin is said to exceed half a million square miles—greater than any other known artesian basin in the world.

To consider the cause and suggest a remedy for the diminution of flow, two inter-State conferences have lately been held (in 1912 at Sydney, and in 1914 at Brisbane), and at the former resolutions were passed urging simultaneous action by the several states to provide for the systematic study and record of the artesian resources, and the control of boring operations and methods in the public interest. The report of the second conference places on record the views of the members as regards the conditions of artesian supply, which are generally those enunciated in Mr. Pittman's paper referred to above. It is held that the observations of the hydraulic engineers in charge of the bores absolutely confirm the conclusions of the geologists in regard to the structure of the artesian basin, the source of the water, and the cause of its flow. The present misapprehension on these points is deplored, and attributed, to a great extent, to "the circulation of certain recent literature which, in view of its effect, can only be described as pernicious"—a somewhat cryptic utterance, the exact bearing of which is not quite apparent. The report dwells on the need of an intelligent perception of the principles involved by those who use the water-supply. This being a national asset, every member of the community has an interest in it and is under obligations to posterity to conserve it, and the conference therefore recommended the imposition of certain restrictions and precautions with a view to minimizing waste. The observed reduction of flow from individual bores is thought to be due rather to a general falling off of the supply in the basin—the result of the overdraught already made upon the supply by the multiplication of uncontrolled bores—than to local causes, and this being so, the need of such control on the part of Government cannot be doubted.*

Attention has so far been given to irrigation from artesian sources of water, but the possibilities of storing and utilizing the supply of the rivers are of hardly less importance. The great schemes for impounding the waters of the Murray and Murrumbidgee in storage reservoirs have at various times been alluded to in the *Journal*, and reports from Australia continue to draw attention to the progress which is being made with the execution of the task, and with settlement on the areas capable of irrigation. By the agreement of 1913 (*Journal*, vol. **43**, p. 697),

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* Mr. Cox suggests that, in part at least, the reduced supply may be due to a periodic diminution in the rainfall, but this is an obscure subject, and it would be unsafe to base conclusions on the uncertain data yet available.

thirty-five locks and weirs are to be constructed on the Murray by the three states of Victoria, New South Wales, and South Australia, with some aid from the Commonwealth Government. It has lately been announced that the ceremony of placing in position the first stone of the first lock and weir across the Murray in South Australia has been performed by the governor of that state. Of the total of thirty-five locks and weirs, South Australia is concerned with six between Blanchetown and the border, besides three in connection with the Lake Victoria storage basin. The result will be a locked navigable river for 235 miles within the state, to which must be added 115 miles from the boundary to Wentworth, N.S.W., besides the permanently navigable stretch of 171 miles from Blanchetown to the sea. A plentiful supply of water will be secured at all times for irrigation as well as navigation, and arrangements are already being made to extend the areas suitable for settlement. A few miles above Renmark, it is estimated that it will be possible to irrigate 20,000 to 25,000 acres of splendid land at the proposed settlement of Ral Ral, while recent surveys have revealed 30,000 acres of first-class irrigable land at Cobdogla. In the existing settlements at Renmark and Berri fruit growing is being prosecuted with marked success. In New South Wales the Murrumbidgee irrigation area offers equally favourable prospects, and farms are being rapidly applied for, those already taken up covering over 40,000 acres. The irrigation channels are being extended and railway extension is also favouring progress, especially in the neighbourhood of Griffith and the Whitton stock route. Survey work is also being carried out in New South Wales on the Murray, both for the location of the locks and weirs in this section, and for the location of irrigable land when water is available.

REVIEWS.

EUROPE.

The Physiography of Iceland.

'An Account of the Physical Geography of Iceland, with special reference to the Plant Life.' By Prof. Th. Thoroddsen. Sect. 2 of Part I. of 'The Botany of Iceland.' Edited by L. Kolderup, Rosenvinge, and E. Warming. Published by the Carlsberg Fund, Copenhagen and London. 1914. Pp. 191–343.

Iceland is of special interest to British geographers, as it is the north-western outpost of Europe, it is our nearest great volcanic region, its foundations date from the same period as the extinct volcanoes of Skye and Mull, it is the home of the typical geysers, its mountains bear vast glaciers, its glacial deposits are widespread and varied, its relief has been greatly influenced by tectonic agencies, and it is the largest remnant of the last land-bridge between Europe and America. The last fact renders the relations of its flora especially instructive, and the editors of 'The Botany of Iceland' have wisely included in the introductory volume a full account of the physiography of the country. They were fortunate in obtaining this valuable contribution from Prof. Thoroddsen, to whom knowledge of Icelandic geography is so largely due. The special feature of this monograph is its account of the "plant formations" in Iceland, of the distribution of the plants and their range elsewhere. The floral statistics quoted are mainly from Warming, who in 1888 enumerated in the Icelandic flora 417 phanerogams and vascular cryptogams, though later estimates have reduced the number. Of these 222 species are also found in Greenland. The

affinity of the Icelandic flora is European, for 42 of its species are European against 2 American. Greenland naturally has a closer connection with America; according to Warming's lists Greenland has 21 American species, and 19 European. Prof. Thoroddsen does not, however, discuss the later contributions to the relations of the Greenlandic flora, and the view that, in spite of statistics, it is essentially American.

The first chapter describes the physical geography of the island; it includes sections on the glaciers; on the variations of the snowline; on the rivers, whose waters are especially rich in phosphoric acid; and on the lakes, of which the largest, Thingvallavatn, occupies a basin due to subsidence along faults. The sections on the geology and volcanoes are of special interest. Iceland consists almost entirely of volcanic rocks, mainly basalts and palagonites, with some liparites and obsidian; some deeper-seated rocks, including granophyres and gabbros, outcrop occasionally, and are of the same age as the volcanic rocks. The only direct evidence of the age of the earlier lavas is given by the formation known as the 'surtarbrandur,' a series of clays with lignites, fossil tree-trunks, and plants. Their age is still uncertain, but Dr. Thoroddsen adopts the view that these fossils are Miocene and indicate a climate nearly 10° C. warmer than that of the present time. The plant beds reach 150 feet in thickness, and occur in the north-western peninsula of Iceland. At Husavik, on the northern coast, are some fossil shell beds, the Iceland Crag, which is correlated with our Red Crag, and is therefore generally regarded as Upper Pliocene. The volcanic eruptions continued through the Glacial period, for lava-flows are interstratified with coarse conglomerates and morainic deposits.

The Miocene eruptions built up a broad plateau-land, which extended from Greenland to Scotland, and rose between 10,000 and 12,000 feet above sea-level; it was broken up by earth-movements at the end of the Miocene. The Pliocene land extended from 30 to 60 miles on all sides beyond the present coasts. The country was lowered by renewed subsidencies, and the submarine coast-platform was formed by denudation; the author does not refer to Nansen's theory of its origin. The Pliocene movements occasioned great fractures across the land, and volcanic eruptions broke out through these fissures. Since the end of the Pliocene Iceland has undergone a long oscillation in level, varying from 500 feet below to 800 feet above its present position. This movement has been accompanied by continued volcanic activity. The known post-glacial volcanoes number 130, and 30 of them have given vent to the 138 recorded eruptions. The lavas include both the aa and pahoehoe types; the pillow variety of the latter does not appear to be dependent on contact with water as some authorities consider necessary. Some of the eruptions have been of great violence; crops were injured in Caithness in 1783 by the fall of "ash" from Iceland; "ashes" from Hekla fell in Germany in 1845; and the Laki eruptions of 1783 occasioned brilliant sunsets over all Europe, northern Africa, and western Asia. In addition to the great volcanic hills such as Hekla there are "crater-rows," of which 87 examples are known. They are lines of small, irregular craters, some 300 to 500 feet high, but usually smaller; the lines are mostly from 3 to 6 miles long, but the longest, Laki, is more than 20 miles in length, and consists of about 100 small craters. Its formation in 1783 accompanied the greatest known Icelandic volcanic outburst, and has been assigned to a fissure eruption. Dr. Thoroddsen gives some support to the existence of actual fissure eruptions, due to lava welling forth from fissures without the formation of recognizable craters; the largest example is at Eldgja, where lavas which cover 275 square miles were discharged from a fissure 20 miles long. The

usual Icelandic volcanoes have normal craters, which are due to the piling up of the lavas around them; others, of which the best known is Viti on Mount Krafla, are explosion craters.

Earthquakes are numerous, especially in three well-defined districts. The more powerful shocks are tectonic, being due to earth-movements; the others occur in connection with the volcanic eruptions. The explosive springs, which owe their name to Geysir in south-western Iceland, are perhaps the most famous phenomena in the country; they are less active than formerly. The first recorded eruption was in 1294. Geysir was most active early last century, and its action is now very irregular, its strength having decreased and the intervals having lengthened. Strokkur, which was once more powerful than Geysir, began to be active in 1789, and has been extinct since 1896.

Among the numerous interesting structures connected with the superficial deposits are the crowded clay knolls and the polygonal meshworks of stones surrounding stoneless clay, which are known as "rudemarks." They are both found in other countries where, during the quick spring thaw, a layer of soft mud lies over frozen ground; the author gives a very clear explanation of their origin.

In the chapter on the climate, among other interesting facts Prof. Thoroddsen refers to the boulders of gneiss and schists brought by drift-ice, which the evidence of the associated driftwood indicates as derived from Siberia.

Prof. Thoroddsen's memoir should be of great service as the best current account of the physical geography of Iceland.

J. W. G.

Balkan Geography and Politics.

'Geographical Aspects of Balkan Problems.' By Marion I. Newbigin, D.Sc. London: Constable. 1915. Pp. viii., 238. *With one Coloured Map and eleven Black-and-white Sketch-maps.* *7s. 6d. net.*

Miss Newbigin has written an illuminating book. It modestly professes to be only a "war" book, but it will take its place at once as a standard book on the geography of the Balkan Peninsula. We expect from Miss Newbigin work that is always stimulating and artistic as well as sound and satisfying; but this volume reaches a high-water mark in its admirable selection of essentials, and in the deft and suggestive treatment of the material thus selected. To the general reader and even to the teacher of geography more detailed description of some features might have been more useful and more interesting than the rather excessive emphasis on their physical history; but we have only gratitude for what she has decided to give us.

All sides of the subject receive equal treatment, and on all the treatment is equally satisfactory; but the special success is in that most difficult of all artistic processes—the selection of essentials. For instance, the discussion of the intercontinental position brings out the vital consideration that "Balkan" routes have always aimed only at crossing the area—from Rome to Byzantium, or from Berlin to Baghdad, and have ignored native peoples and native products. So the fundamental skeleton of relief is shown to be a core of hard old rock (Rhodope) surrounded by young folded lines, from which the core is separated by gorges that mark the line of differential erosion. As the barren core repels Man in time of peace—though offering a refuge in time of danger—there has been no natural centre for the nucleus of a great Power; and, in the absence of any great political unit, special importance has attached to a great ecclesiastical unit. Again, owing to the relatively easy movement north and south

along the two great gorges, with their common northern trunk, native peoples have representatives outside the area, and foreigners have intruded into it. And these intruders could send off lateral swarms into the numerous basins (polyen) that flank or include the great routes, thus causing confused mixture of race; but neither the intruders nor the natives could form a strong political unit. And, once more, the physical history has involved wide interference with the original flow of water, causing the mass of it to converge on the Ægean, and human activities naturally followed it, especially as the non-Mediterranean products of the summer-rain area seek markets in the summer-drought area of the Mediterranean.

In the applied geography, amongst many other admirable things—political and economic—there is a convincing analysis of the Greek position. The Greek can assimilate the Slav in the peninsular south, with its summer drought, its gardening, its sea commerce, because to all three the Slav is alien; but he fails himself in the continental basins, with their summer rain, because he is not a ploughman. Even in his own Thessaly he can neither tackle the agrarian problem nor maintain the population, though elsewhere in Greece overproduction of currants leads to wide emigration.

The present reviewer bought the book "at sight," and he can only recommend every one else to do the same; but he has a prejudice to air and a complaint to make. As to the former, with her delightful command of virile and flexible English, why does the author so often use the phrase "on *the* large scale," when she simply means "on *a* large scale"?

As to the complaint, it is about the treatment of the Albanians. They are the one indigenous race in the area; they have a vivid nationality; they have survived against Slav and Bulgar, Turk and Greek; they are the most ancient people in Europe, speaking a language older than classical Greek; and they have proved, for two thousand years, incapable of being assimilated. To describe them as "a comic opera" people (p. 231) is unworthy of all the rest of the book, with its very marked and distinctive merits, and it shirks the most difficult problem in the whole peninsula.

L. W. L.

'Russian Realities.' By John Hubback. (London: John Lane. 1915. Pp. xv., 279. *Maps and Illustrations.* 5*s.* net.) A collection of traveller's impressions of country and people, gained during eleven short visits to Russia within the last five years. The book is chatty in style, and has many interesting allusions to incidents and conditions bearing on the war. Two chapters on South Russia in Spring and Summer give a good idea of the character of the steppe country, and the changes produced in its aspect by the changing seasons.

ASIA.

The First Dutch Voyage to the East Indies.

'De Eerste Schipvaart der Nederlanders naar Oost-Indië onder Cornelis de Houtman, 1595-97. Uitgegeven en toegelicht door G. P. Rouffaer en J. W. Ijzerman. Part I. 's Gravenhage: Martinus Nijhoff. 1915. *Frontispiece, Portraits, Maps, and Plates.*

That the epoch-making voyage of Houtman to Java in 1595–97, which opened up to Holland the Indian Archipelago, would sooner or later engage the attention of the Linschoten-Vereeniging was a foregone conclusion; and in the volume before us we have the first of the three which the Society proposes to

devote to the subject. This one contains the chief authority for the voyage, viz. the narrative of Willem Lodewycksz (who himself took part therein), published at Amsterdam in 1598. The illustrations comprise all the plates and maps of the original edition, together with the author's map of Java and Sumatra, which was to have been included in his work but was not ready in time; and in addition we are given a useful modern map, portraits of the two Houtmans, and a reproduction of a painting depicting the return of the fleet. A second volume is to gather together other materials which have already seen the light; while a third will give a number of hitherto unpublished documents, together with a commentary on the voyage and its results, a bibliography, and a general index.

Like all the publications issued by the Society the present volume is excellently printed and bound, liberally illustrated, and admirably edited. The narrative itself is worthy of the attention bestowed upon it, for with true Dutch thoroughness Lodewycksz did not content himself with relating the events of the voyage, but wherever the fleet touched—at the Cape, Madagascar, Java, Madura, Lubuk, and Bali—he investigated the local flora and fauna, noted the customs and dress of the natives, and made careful inquiry into the course of trade. All this has provided ample opportunities for the two editors, who are to be congratulated on the excellent notes with which they have enriched the present edition.

A word may be added about the Linschoten-Vereeniging itself. Founded about six years ago, on the model of our own Hakluyt Society, it has already established a claim upon the gratitude of all students of geographical literature. The annual subscription is only ten gulden (about 16*s.* 8*d.*), for which sum the Society's publications are supplied post free. This being so, it is somewhat remarkable that the Society finds so little support in the United Kingdom, only ten English names (including seven libraries) appearing in the list of members; but probably these facts only need to be known to secure a considerable increase. W. F.

'In the Lands of the Sun.' By H.R.H. Prince William of Sweden. (London: Eveleigh Nash. 1915. Pp. xii., 344. *Illustrations.* 16*s. net.*) These "notes and memories of a tour in the East" originated in a visit to Bangkok in 1911 by the second son of the King of Sweden. The Prince headed the official mission which represented Sweden at the coronation of the King of Siam. Subsequently he and his suite toured in Siam, French Indo-China, India, and Ceylon. The book is written in a sprightly style. The Prince, who has served in the Swedish navy, is of an adventurous disposition, and when he had to make choice between a visit to the famous Cambodian ruins at Angkor and a shooting trip, he decided in favour of the latter. Other members of his party, however, visited Angkor, and a long and interesting chapter by Chamberlain H. Bildt describes the ruins and the measures taken by the French for their examination and preservation.

AFRICA.

The Franchetti Mission in Tripoli.

'Le Missione Franchetti in Tripolitania (Il Gebel).' Firenze, Milano: Fratelli Treves. 1914. 15*s.*

This solid and exhaustive treatise on the labours of the mission that was appointed in November, 1912, to proceed to Tripoli represents the fruit of the

researches of the six members to whom the inquiries were entrusted. The head of the mission was the Senator L. Franchetti, who was accompanied by five professors, each a specialist in his own particular line of study. These comprised subjects such as (1) the social and economic conditions of the natives; (2) topography, geology, and water-supply; (3) flora and botany; (4) agriculture; and (5) pasture and grazing. It would be quite beyond the scope of a short review to convey an accurate idea of the resources and character of so extensive a country as the new possession acquired by Italy in Tripolitania. The Jebel or tableland to which the descriptions and photographs of the present work mostly apply comprises two large tracts (Gharian and Tarhuna) of the hinterland south of the ports of Tripoli and Homs; these tracts are scantily watered by the "wadys" or intermittent substitutes for streams, which for the most part flow from the steeper parts of the Gebel across the lowland to the sea-coast. Trees are not plentiful, and such kinds as olives, jujubes, acacias, palms, figs, etc., are only sparsely to be found, as may be seen from the numerous photographs with which the work is illustrated and which on the whole convey the idea of a somewhat sterile and forbidding landscape. Here and there, however, some well-wooded clumps of fairly luxuriant and well-shaped olive trees present quite a European aspect, and seem to picture the general features of an English park. The general information supplied in the careful and voluminous notes, more particularly in reference to the natural resources of this ancient Roman dependency, should prove most instructive and serviceable to those officials to whom the development of the country will be entrusted hereafter.

Egypt.

'An Englishman's Recollections of Egypt, 1863 to 1887.' With an Epilogue dealing with the present time, 1914. By Baron de Kusel (Bey). London: John Lane. 1915. *Map and* 32 *Illustrations*. 10*s*. 6*d*. *net*.

Baron de Kusel's recollection covers a very interesting period in Egyptian history. When he went to Egypt slaves were openly sold in the markets, and Ismail had just succeeded Said Pasha as viceroy. When he left Sir Evelyn Baring (Lord Cromer) had been four years Agent General. The author was in Alexandria during the great cholera plague (1865); he was one of the guests at the opening of the Suez Canal; he was present in Abdin Square when Tewfik capitulated to Arabi; he rendered conspicuous service in Alexandria in 1882, and gives us an excellent account of life in the city before and after the bombardment. In short, Kusel Bey, who was for ten or twelve years Controller-General of the Egyptian Customs, writes at first hand about many stirring events; and if he tells us little which may be called strictly geographical, he reproduces the atmosphere of Egypt. His knowledge of Arabic helped him to gain the friendship of the natives, and though his book is largely anecdotal and lightly written there is in it an undercurrent of seriousness, and his sympathy with the people whose lot he helped to alleviate is apparent. His account of the Zobeir-Gordon incident in 1884, in which he played some part, contains hitherto unpublished information. In an epilogue Baron de Kusel (the title is Italian, granted for services to the Italian community in Egypt) records the accession of Hussein Pasha as Sultan. The illustrations, mostly from old prints, are quaint and acceptable.

F. R. C.

Bushmanland.

'Lodges in the Wilderness.' By W. C. Scully. London: Herbert Jenkins. 1915. *Four Illustrations from water colours.* 5s. *net.*

This book describes journeys undertaken some twenty years ago, but the Great Bushmanland Desert has not changed in the interval, nor will it change unless some gigantic irrigation works are carried out and the wasted waters of the Orange made to fertilize the land. The desert retains yet its mystery and fascination for those wanderers who desire "a lodge in some vast wilderness," though "the boundless contiguity of shade," also longed for by the poet, be lacking. In the desert there is no shade save in some gorges in the black and naked mountains, gorges so deep that, except at noonday, no sunbeams penetrate them. Under the stress of war a railway has been built this year, linking the Cape and South-West African systems. The traveller can reach the edge of the desert with ease, and Bushmanland may be more frequently visited. No one should go thither without Mr. Scully's book for guide. It pictures the desert as a semi-sentient thing, with its burning sun and nights of exquisite loveliness; its shifting and tentacled sand-dunes; its strange and gorgeous flowers; its springbok, oryx, and ostrich, and "hooded yellow death"—the cobra. Then, too, we have Andries, the large-limbed and large-hearted Boer, whose desert craft is a never-failing source of wonder. Fortunate indeed are the folk who learn of a strange land in Mr. Scully's school, though he should have known better than to leave his book without a map.

Two chapters are given up to an account of a journey in the Richtersveld, that out-of-the-world region enclosed in the big curve of the Orange just above its estuary. Its inhabitants are a very primitive folk, a mixture of Hottentot, Bushmen and Dutch, and at the time of Mr. Scully's visit were ruled by an elderly, courtly, coloured clergyman, the resident missionary. Here, as at the Roman Catholic station at Pella further up the Orange, the missionary represents the strongest human agency influencing the dwellers in Bushmanland—no longer Bushmen.

F. R. C.

AMERICA.

Vancouver and his Island.

'Archives of British Columbia.' Memoir No. 1. 'The First Circumnavigation of Vancouver Island.' By C. F. Newcombe, M.D. Victoria, B.C. 1914.

The claims of Vancouver to the credit of the first circumnavigation of the island which bears his name are so generally recognized that it might be thought needless to undertake a re-examination of the evidence with a view to their vindication, as has been done in the work now before us. Although the Spanish expedition under Galiano and Valdes was navigating the interior channels in 1792 almost at the same time as the British navigator, an examination of dates in the records of the two undertakings suffices to show not only that the British boat parties under Johnstone and Swaine completed the navigation of the channels a month before the Spaniards, but that Vancouver himself reached the ocean with his ships a few days in advance of them. These facts have hardly been disputed, but Vancouver's priority over his *American* rivals, at work in the same field at the same time, has seemed to some more difficult to establish, in the face of the well-known story of Meares that the channels in question had been navigated in 1789 from end to end by Captain Kendrick in the American sloop *Washington*, although even at the time the story found little

credence, and confirmatory evidence has throughout been entirely lacking. The publication of Dr. Newcombe's study is, however, by no means to be regretted, as besides supplying a useful view of early speculations on, and actual exploration of, the inner channels of this complicated coastline, it puts forward new material of much value in the form of extracts from unpublished and little-known contemporary documents. The principal of these are: (1) the fragment of a narrative written by John Hoskins, of the American ship *Columbia Rediviva* (Captain Gray), which originally sailed with the *Washington*, describing voyages to North-West America in 1780–93; (2) a narrative by Robert Haswell, mate successively in the *Washington* and *Columbia* during voyages in 1788–89; (3) the journal kept by Captain Joseph Ingraham, while in command of the brigantine *Hope* in 1791 and following years; he had previously served as mate under both Kendrick and Gray. The writers of all these had special opportunities of meeting Kendrick subsequently to his supposed navigation, but neither they nor others who had similar chances of knowing the facts say a word to confirm Meares's story. Ingraham, in fact, explicitly denies its truth. Dr. Newcombe does not always present the sequence of events quite so clearly as could be wished (*e.g.* the exchange of ships between Gray and Kendrick in 1789 is not mentioned until the reader has been considerably puzzled to know which commanded each at any given time), but the book is none the less of distinct original value. It is copiously illustrated by facsimiles of early charts of this coast, including those of Wedgborough and Hanna (both made in 1786), Duncan (1788), and Ingraham (1791–93).

Climate of Chicago.

'The Weather and Climate of Chicago.' By Henry J. Cox and John H. Armington. (Geographical Society of Chicago, Bulletin No. 4.) Chicago, 1914. 10 × 6½. *Tables, Maps, Diagrams, and Illustrations.* Pp. xxii., 375.

This is an elaborate statistical volume about the weather of Chicago from the time far back in the last century when official records in the city were first established, and its utility is brought into prominent relief by the absence of any similar modern treatise on the weather and climate of London and many another capital. However systematic and lengthy London's meteorological record may be, the inquirer has to search through diverse meteorological periodicals for anything he wants to ascertain, and often, indeed, to enter into correspondence with the officials in charge of the records. But in the compilation before us the tabular matter relating to means and extremes of temperature, precipitation, wind pressure, sunshine, etc., is so copious and fully discussed as to embrace practically everything capable of being yielded by the continuous daily records on which it is based. After an Introduction, the body of the work deals successively with Temperature, Precipitation, Atmospheric Moisture, Cloudiness and Sunshine, Wind Direction and Velocity, Barometric Pressure and Storm Tracks, and ends with a general summing up. Probably the first thing which will strike the reader is that the climate of Chicago, in common with that of much of the United States, is apt to be extreme in its manifestations and violent in its changes to a degree quite unfamiliar to residents in the British Islands—despite the great variability of our weather from day to day. The climate, in short, is anything but tame and monotonous—a fact, indeed, repeatedly noted by the authors as being conducive to the activity of the inhabitants.

It is well known that the isothermals of 40° and 50° Fahr. trend further south across the North American continent than in North-Western Europe, but it is nevertheless rather surprising to find that the mean annual temperature of

the city, at an altitude somewhat less than 600 feet and in latitude 41° 45′ N., is only 48°·8 Fahr., or just a degree lower than that of London, which lies 10° further north. The temperature of the air, however, does not represent the complete climatological picture, and it must be remembered that its more southern latitude ensures to Chicago a greater intensity of direct radiation from the sun than falls to the share of London. The seasonal range of air temperature is, as one would expect, great, ranging from a mean of 24°·1 Fahr. in January to 72°·4 Fahr. in July. In a table giving mean daily temperatures on the basis of the period 1872–1910, the warmest date is assigned to July 16 with 74°·6, and the coldest February 1 with 21°·2. But in order that the irregularities due to the insufficient length of the period may be smoothed out, the authors give another table of adopted daily normal temperatures, according to which the warmest days of the year extend from July 15 to August 5 with a temperature of 73°, and the coldest from January 17 to February 4 with 23°. They nevertheless seem to attach real significance to July 16 and February 1 as the warmest and coldest days in the year, and attempt an explanation why the latter date should occur so much later after the winter solstice than the former after the summer, which, we think, is somewhat novel, but hardly very convincing. "Von Bezold," they say, "divides the earth into three zones, an equatorial zone in which insolation is considerably greater than radiation, and two polar zones in which the amount of radiation is greater than the amount of insolation, and fixes the boundaries at between 35° and 40° of latitude. Plainly the equatorial or insolation zone would be marked by higher and higher temperatures each year, and the polar or radiation zones by temperatures becoming lower and lower, were it not that the excess of heat in the one is transferred by convection (circulation) to the two radiation zones, thus maintaining the mean annual temperature. Chicago is situated just within the north radiation zone, and this explains why the minimum temperature of winter is retarded to a seemingly undue extent; and also why the period of excess heat in summer is shortened, thus advancing the time of maximum temperature." Now even supposing that the abnormally late date of February 1 for maximum cold in a continental region is real and not accidental, the theory launched to account for the anomaly does not, so far as we are aware, derive support from the existence of the same anomalous feature in the annual temperature swing in other parts of the world; the Greenwich figures certainly fail to indicate it. Moreover, on the basis of the *adopted* normals for Chicago, the anomaly in question disappears.

We have not space to dwell upon the other important elements of rainfall, sunshine, storms, and blizzards; but we cannot refrain from mentioning in conclusion one very pleasing feature of the book, and that is the constant reference to Lake Michigan—not only as a beneficent mitigator of the severe hot and cold waves to which Chicago like other American cities is subject, but also as an unfailing source of pure health-giving breezes. The proximity to this inland sea is a great health asset to a city located in the interior of a vast continent, and great prominence is given throughout the work to the importance of Lake Michigan as a local climatic factor.

L. C. W. B.

GENERAL.

A Voyage to Kerguelen.

'Fifteen Thousand Miles in a Ketch.' By Captain Raymond Rallier du Baty. London: Thomas Nelson & Sons. Pp. 374. *Frontispiece.*

Captain Raymond du Baty, of the French merchant service, accompanied Dr. Charcot as mate on the French Antarctic Expedition of 1903–5. Deeply imbued with the love of travel and adventure, Captain du Baty afterwards joined forces with his brother, also a captain in the French merchant service, and organized a miniature expedition to Kerguelen. They bought a ketch of 45 tons for £60, spent something like £600 in making her shipshape, renamed her *J. B. Charcot*, and finally set sail in November 1907 with a crew of four, including a lad of sixteen. Kerguelen was reached in March of the following year, the only places called at on the way being Rio and Tristan da Cunha. A stay of nearly fifteen months was made at Kerguelen, and then the voyage was continued to Melbourne, which was reached at the end of July, 1909.

The expedition made various additions to knowledge of the geography of the Kerguelen group, and collected other scientific data; but Captain du Baty makes few references to this side of the expedition's work in the volume under notice, which is an English pocket edition of a popular account of the enterprise. The voyage lends itself to treatment in this way: it was a hazardous venture for a cockle-shell like the *J. B. Charcot*. Prince Roland Bonaparte put the matter in a nutshell when he said, at the reception of Captain Raymond du Baty by the Paris Geographical Society, "You are sixteenth-century adventurers who have been lost in the twentieth." As a writer du Baty has a lightness of touch which is characteristically French. The translation admirably preserves the verve and esprit of the original, and the result is a book of travel of rare literary charm. It contains a very interesting account of the visit to Tristan da Cunha, with a brief history of the settlement there, and leaves a vivid impression of the storms which rage round Kerguelen, making that group a worthy offshoot of Sir Douglas Mawson's 'Home of the Blizzard.'

THE MONTHLY RECORD.

EUROPE.

Earthquake in Cumberland on October 2.—An earthquake, of moderate strength for this country, was felt over a large part of Cumberland on October 2, at about 3.15 a.m. The disturbed area is about 55 miles long, 37 miles wide, and contains about 1600 square miles. The chief interest of the earthquake lies in its probable connection with the Carlisle earthquakes of July 9, 1901. On this day three earthquakes were felt, and two days later a fourth. The first and strongest disturbed an area 66 miles long, 46 miles wide, and containing 2390 square miles. It was a twin earthquake originating in two detached foci more than 20 miles apart, and was probably connected with a long north-and-south fault traversing the crust beneath the Lake District. As the recent shock disturbed an area very nearly the same as that in 1901, it was probably due to a movement along the same deep-seated fault.

ASIA.

The Date Industry at Bussora.—In view of present happenings on the lower Euphrates and Tigris, some notes on the date industry of Bussorah, sent to us by Mr. H. W. Poulter, late American consular representative at that place, are of some

interest. The date season lasts from September to November, and during that time occupies the activities of a large part of the population. The trees are planted out in lines, one hundred to the acre, and irrigated by canals dug through the gardens. During June arrangements for the packing of the dates when ripe already begin, goods being taken upstream to be handed over to the sheikhs of desert Arab tribes, who supply under contract the labour for packing—this being done by women. (Local residents are also employed, as far as available, and are much more capable than those from the desert.) By September 15 the dates are almost ripe, and the town assumes an appearance of unwonted activity. Meetings are held between the principal merchants and date growers and prices fixed for the kinds of dates exported. These are practically restricted to three—hellawi, khedrawi, and sayer—though altogether some fifty-six varieties are grown. A general exodus to the packing places—built on the river-banks and creeks where supplies of dates are available—now takes place. The packing is done in long, low structures of reeds and mats, each capable of accommodating some two hundred workers. Huts are also provided for the native clerks and desert Arabs. The ripe dates are cut, conveyed to the packing places, and sorted—the good separated from the bad, and, after removal of the basal sheath, packed one by one in boxes of about 70 lbs. each, the layers being pressed down by means of a smooth plank slightly smaller than the box. The boxes are loaded into lighters, and from these into steamers bound for France, England, or America. The wood for the boxes is imported from Norway, Russia, and formerly Austria, ready cut into lengths. The date grower has a comparatively easy time, the chief risk arising from the flooding of the gardens by the rivers, which causes the dates to fall from the trees while still green. The tax imposed by the Turkish Government was by the tree, irrespective of yield.

AFRICA.

Temperature Conditions in Central and West Africa.—Meteorological data for Africa have been steadily accumulating for some years, though the stations for which any lengthened and continuous series of observations is available are still limited in number. Something has been done, too, to work up the raw material into a form useful to students, but a good deal still remains in the crude form or is not easily accessible. The French traveller and geologist, M. R. Chudeau, has done a useful piece of work in tabulating the results as regards temperature for the principal French stations in West and Central Africa for which records exist (*Comptes Rendus*, Paris Academy of Sciences, August 2, 1915, vol. **161**, No. 5). The stations, sixteen in number, range from Insalah in the Sahara to Loango north of the Congo mouth, and from St. Louis in Senegal to Fort Lamy in the Lake Chad region, and the length of the series of observations varies from three to thirteen years. The data have been taken from the *Annales du Bureau Central Météorologique*, and are given in the form of monthly and yearly means. M. Chudeau calls attention to some points of interest brought out by the table. At Insalah there is a maximum in July and a minimum in January (or more rarely in December). The departures from the mean are here considerable. Further south two maxima with intervening secondary minimum make their appearance; the minimum is clearly marked at Timbuktu, as at Khartum, and by 10° N. lat. takes an equal importance with the winter minimum. Whereas the amplitude, or difference between the mean maximum and minimum, amounts to some 18° C. at Insalah (where frost is of no unusual occurrence), and is still high during the dry season at Timbuktu, it is both lower and less variable further south. As might be supposed, it is much smaller at the coast stations, where the temperatures likewise suffer a disturbance owing to the rise of cold water from the depths of the

ocean; but this effect is not felt far inland. The great West African forest is seen, too, to exercise a moderating influence, especially at the season of active vegetation. Certain corrections are needed in the course of the isotherms across the continent as commonly drawn. Whilst the annual mean is a little above 30° C. at Khartum and Kassala, the value diminishes towards the west. In January there are considerable areas north of the forest region in which the mean temperature exceeds 27° C. and even 28°, and in July the isotherm of 35° C. includes a much more limited area than is usually shown, but embraces Tuggurt, El Golea, Insalah, and Murzuk.* The minimum of the Guinea forest is well marked in this month.

The Jibuti—Adis Ababa Railway.—The railway from Jibuti, the French port on the Red Sea, reached Adis Ababa, the capital of Abyssinia, on May 21 last. The line, which has a length of some 490 miles, has taken eighteen years to build. Begun in 1897, it was completed as far as Dire Dawa (the station for Harrar, 25 miles S.S.E.) in 1903. The first 64 miles run through French Somaliland. Political and financial difficulties caused much delay, and it was only in 1909 that the next section, to the Hawash River, was begun. The Hawash was reached on December 31, 1913. The final section—150 miles in length—presented many difficulties, as the railway had to climb the Abyssinian plateau, and progress was necessarily slow. The station at Hawash is 2788 feet, and that at Adis Ababa 7710 feet above the sea. The railway is of metre gauge, and is the property of a French company, but equality of treatment of the merchandise of all nations is guaranteed. By international agreement the right to build railways west of Adis Ababa is reserved to Great Britain, the intention being to connect the capital with the Sudan railways and Uganda.

Railway Progress in Morocco.—The West Moroccan railway, on the narrow gauge of 0·60m., begun by the French for purely military purposes in 1911, reached Fez on February 5 last. It is 114 miles long, starting from Casablanca and passing through Rabat, Salle, Kenitra, Dar-bel-Hamri and Meknez. In Eastern Morocco a railway has been built from the terminal station of the west Algerian Company by Ujda to Taza, the rails having reached Taza on July 14. It is 153 miles by this railway from the Algerian frontier to Taza. Between Taza and Fez, a distance of 56 miles, a motor omnibus service has been established. The conventions relating to Morocco forbad these military lines being used for ordinary traffic, until the Tangier-Fez line had been begun, but as one result of the war with Germany the restrictions on the use of the lines are no longer binding on France and the Resident General has announced that the Casablanca-Fez railway is open to the public as far as military needs permit. Another 0·60m. railway goes from Casablanca towards Marakesh. For about half the distance, that is to Meshra, 78 miles from Casablanca, the line is open.

AMERICA.

Physical Boundaries within the United States.—In the *Annals* of the Association of American Geographers (vol. 4) Professor N. M. Fenneman has published a monograph under the above title. His aim is to define the boundaries of the physiographic divisions of the United States more accurately and precisely than has yet been attempted. He points out the need for agreement by geographers as to

* The isothermal charts prepared for use in Egyptian schools and reproduced by Mr. Craig in the *Cairo Scientific Journal* for 1911 (p. 124) do not show any July isotherm higher than 32° C. for this part of the Sahara. On the other hand, a considerable part of the Egyptian Sudan is there enclosed by the July isotherm of 34° C.

the exact delimitation of the regions with which they deal. Hitherto the boundaries have only been broadly indicated so as to serve for a study of the United States as a whole, and they have proved inadequate for detailed study and for work in the field, *e.g.* particular small districts may be differently grouped by different workers, and this may lead to serious confusion. The present division is made primarily from the point of view of the physiographer, for in the first place it is to aid in the description and study of the physical features of the country. But the author believes that such a division will also serve as a basis for the treatment of the other geographical conditions, especially those more immediately connected with human activities. His position is that topography and soils are the product of the physiographical processes on the one hand, and on the other they are of fundamental importance in the physical environment of man. Topography and soils, therefore, are the factors of primary importance in this delimitation which is to serve the double purpose; hence geological considerations are to be taken into account when they control the topography or the soil conditions, and not elsewhere. Yet, even with this limitation in mind and with the realization of the fact that geological classifications are based on the age of the rocks and do not necessarily have a geographical significance, the author considers the geological map to be the most useful aid in indicating physical boundaries. The reason for this is that "unity or similarity of physiographical history" is the key to the problem, for where the history is alike the result is uniform, so that the divisions thus made coincide with those based upon topography. Thus "a physiographic unit is an area which is characterized throughout by similar or closely related surface features, and which is contrasted in these respects with neighbouring areas." In the main the division of the United States is based upon that made by Powell in his Physiographic Monograph, and used by W. M. Davis in the masterly general survey published in the 'International Geography.' Some boundaries have been considerably altered and some subdivisions made, but the chief aim has been to find the exact boundaries to the divisions. These are broadly indicated on the sketch-maps, and exactly defined by reference to the geological maps and to topographical features recorded on the contoured maps and visible in the field; reasons are given for the selection of particular lines, and in some cases alternatives are suggested. Of the two larger-scale maps, the first distinguishes between the boundaries from the point of view of their definiteness: where they are quite marked and clear a firm line is drawn; where there is a narrow transitional zone a line of crosses is employed, while a broader transitional zone is shown by a broader cross-hatching; arbitrary or less important boundaries are shown by a dotted line. The second map exhibits the basis of the delimitation: different markings are employed to show whether the boundary is one of the divisions shown on a geological map; a structural line which, however, is not such a "geologic contact"; the foot of a mountain or scarp; a contrast between two topographical types regardless of elevation; a present stream divide, or an old shore-line. The paper is of considerable general interest as an example of one method of delimiting "natural regions," and of great value as a basis for future work on the geography of the United States.

The Takutú River, British Guiana.—The note on this river inserted in the October number, calling attention to the view of Mr. W. G. White that the Ireng and not the Takutú is the true upper course of the eastern branch of the Rio Branco, has elicited a communication from Lieut. R. H. Blake, R.E., in which the more orthodox view is upheld. Lieut. Blake surveyed the region of the upper Rio Branco in 1912–13, making his headquarters for some days only a few hundred yards from the junction of the two streams in question, and his opinion should therefore carry weight. He says that the Ireng is very much narrower than the

Takutú, and that he has always looked upon it as simply a tributary of the latter. He draws a rough memory sketch in which the Takutú is shown as flowing round in an even sweep past the mouth of the Ireng, which is only about half its width and joins at an angle. He has lived with local Indians of various tribes, but has never heard any part of the Takutú referred to by any other name, though the Ireng is spoken of as the Mahú on the British Guiana side. It may be noted that such travellers as have visited the spot from the time of Horstman (1739) onwards appear to have regarded the matter in the same light, and more substantial evidence would seem to be needed before a change in our maps would be justified.

Colonel Rondon's Work in Matto Grosso.—It will be remembered that the Roosevelt-Rondon expedition down the river now known officially as the Rio Theodoro was the outcome of Colonel Rondon's previous explorations about its headwaters, carried out in connection with his task of opening up overland communication from south-eastern Brazil to the region of the Amazon and Madeira (cf. *Journal*, vol. **31**, p. 568). According to a letter lately received by Colonel Roosevelt from Colonel Rondon, and referred to in the September number of the *Bulletin* of the American Geographical Society, the construction of the telegraph line has now been completed, the final section down the Gy-Parana River to the Madeira having been constructed during the last eight months of last year. Road making has gone on simultaneously with the making of the telegraph line, and success has been attained in the pacification of the Indian tribes. Last February Lieut. Marques de Souza was despatched on an exploring expedition down the Ananáz River from its headwaters where crossed by the telegraph line. It is thought to be the upper course of the Aripuana, the chief right-bank tributary of the Rio Theodoro.

Surveys in Eastern Colombia.—A further report on the work of the "Oficina de Longitudes" in the Republic of Colombia (*Journal*, vol. **35**, p. 81; **38**, p. 533) is given in the *Boletin del Ministerio de Relaciones Exteriores* for 1914 (vol. **6**, pp. 152–170). It deals with a journey carried out early in 1914 in the eastern parts of the republic (Cundinamarca and Boyaca) by Señores Garavito and Rozo for the purpose of determining geographical co-ordinates by means of astronomical observations coupled with telegraphic determinations of longitude. Dr. Rozo's narrative of the trip contains some useful notes on the places passed through on the way, their productions and industries, and the general state of the country. Reaching the upper course of the Meta, one of the great western tributaries of the Orinoco, the party descended it in a boat as far as Orocue, the limit of steam navigation from the Orinoco, where the two principal commercial houses are in German hands. The place, which steamers visit only twice in the year, exports hides in some quantity, cattle-rearing being the principal occupation in this region of llanos. The plumage trade appears to have extended its destructive activities even to this remote spot, and the value of egret feathers exported is said to exceed half a million dollars. Most of the money circulating here is Venezuelan, but the Colombian Government has lately taken steps to extend the use of its own currency. Civilization does not seem to have made much advance up to the present, and some of the centres of population are described as having lost their former importance. The roads are mere cattle-tracks, and much need improvement. The return route led north-west, past Trinidad, Pore, and other settlements, in which cock-fighting is in great vogue, the birds being reared in every homestead. A certain amount of cotton, coffee, sugar-cane, etc., is cultivated. The Cordillera was crossed by the Páramo de San Ignacio, and during the western descent the aspect of the country changed with startling rapidity. During the whole journey astronomical and meteorological observations were taken at every halting-place, and are placed on record in tabular

form, though the results have not yet been worked out. Seventeen telegraphic exchanges of signals were effected.

AUSTRALASIA AND PACIFIC ISLANDS.

Town Planning in Australia and New Zealand.——That the science of town planning requires to be more carefully studied than it has in the past is now generally recognized, and it may be hoped that in countries or localities where a clear field is open to the planner, the towns of the future may benefit by the clearer comprehension that is being gained of the needs and principles involved. An interesting article on the history of town planning in Australia and New Zealand, contributed by Mr. W. R. Davidge to the *Journal of the Royal Institute of British Architects* for July 31 last (vol. **22**, No. 17), will be a help in this direction, as setting forth both examples to be followed and mistakes to be shunned. Town planning in the early days of settlement in that part of the world started with considerable advantages. The sites were previously unoccupied, and those responsible for the foundation of new towns were, to some extent at least, alive to the requirements of the subject. But they were unfortunately, as Mr. Davidge points out, hampered by the necessity of expedition in carrying out the survey, design, and pegging out of the sites. As a result nearly all colonial towns have been surveyed and laid out in streets either at right angles to a river, or along a meridian, and in many cases the sites have been rectangular blocks measuring perhaps a mile in each direction. Little or no account has been taken of the natural features of the ground, or of the needs of traffic, the radiate arrangement of streets so advantageous from the point of view of the latter being rarely met with except as survivals from the old stock roads in existence before the planning of the town. On the other hand, the abundance of space available led to the adoption of wide streets and the provision of open spaces in the form of park lands surrounding the original settlement, as at Adelaide. Concrete examples of the advantages and defects of various Australian and New Zealand towns are given in the paper, which is fully illustrated by plans and photographs. The failure of the rectangular plan, carried out in disregard of the natural contours, is most marked in the case of towns built in hilly country, and is exemplified by the case of Brisbane, where, in some of the suburbs, the gradients are as high as 1 in 3. For smaller towns the rectangular block plan has proved less disadvantageous. The latest effort towards a really scientific plan is that of the new Federal capital of Australia at Camberra, as designed by Mr. W. B. Griffin, of which, in its revised form, an illustration accompanies the paper. In New Zealand excellent examples exist, as at Dunedin, of the provision of belts of town lands on a liberal scale, and width of street is also a feature, it being laid down by law that each township must have one principal street 99 feet wide. In the case of Christchurch, originally laid out on the customary square mile of ground, this has naturally been overstepped, and it is curious to find that in the outskirts the old radiating bullock tracks have grown into natural highways, the regularity of plan not being maintained. Wellington and Auckland have experienced difficulties, the one from the steep mountain-sides rising abruptly behind the town, the other from the deep gullies which traverse the site. But these difficulties have been partly at least overcome by engineering skill. Auckland, like Sydney, is provided with an excellent ferry service, which greatly helps internal communications.

The Name New Guinea.—In discussing the spelling of this name which should logically be used by the Dutch, a writer in the *Tijdschrift* of the Netherlands Geographical Society for July, 1915, brings together some interesting facts as to the various early forms of the name, and his remarks are followed by a note by

Dr. F. C. Wieder on the earliest use of the name in print. The first writer, who signs himself "L'H. N.," considers that the form Nieuw-Guin*ea*, officially adopted in Holland, should be replaced by Nieuw-Guin*ee*, the form Guinee having the priority among both the Portuguese and Dutch for the West African coasts, identified by the former with the gold country of Jenne in the upper basin of the Niger. The name was given to the eastern island by the Spanish navigator, Ortiz de Retes (1545), in the Spanish form, Nueva Guinea, and the fact that this was latinized Nova Guinea by the Flemish map-makers of the sixteenth century no doubt gave currency to this spelling of the main word, though the French, more consistently, have always used the form La Nouvelle Guinée. It is sometimes stated that the first appearance of the name in print was in Mercator's planisphere of 1569, but Dr. Wieder points out that the island is shown (as Nueva Guinea) in Ruscelli's Ptolemy of 1561, and (as Nova or Noua Guinea) in Galvano's well-known history of 1563, and in Ortelius's World-map of 1564.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

The Distribution of Leguminosæ and Past Geographical Changes.—The importance of the study of plant and animal distribution for the understanding of past geographical changes has long been recognized, and for this purpose there are probably few groups which afford material of greater interest than the great natural order of Leguminosæ. The development and distribution of this is the subject of a paper by the well-known Australian geologist, Mr. E. C. Andrews, published in the *Journal of Proceedings* of the Royal Society of New South Wales, vol. **48**, and also issued as a reprint. The writer, who had previously discussed the significance of the distribution of the order Myrtaceæ, points out that these two orders occupy a similar position in relation to the problem of former tropical land connections, since each appears to have descended from groups of uniform primary types, widely diffused through the tropics in the past, and showing varying modifications in the different extra-tropical regions to which they have spread. As they have accommodated themselves to temperate regions only in later geologic time, neither helps much to a knowledge of former land-connections with the Antarctic continent. The paper is divided into a number of sections dealing with general questions of geographical distribution and early geography as well as with the actual distribution and past history of the leguminous order and its main representatives. They are perhaps a little disconnected, and the thread of the argument is not quite so clearly traceable as might be wished, but the general conclusions are briefly summarized in the introductory section. The widely diffused tropical types, as above noted, are generally uniform, and in the main luxuriant in habit. In extra-tropical countries, such as Eurasia, South Africa, and Temperate Australia, they are represented by specialized types. It would appear that the tropical lands of the present were connected during one or more previous periods, and that a genial and moist climate extended far beyond their present limits. Here the primary types were widely spread. New Zealand was early separated, while Australia was cut off considerably later. About the date of its separation a climatic differentiation involving a contraction of the genial and moist climate of earlier times took place, with the formation of high mountains, large continents, and great deserts. The primary types of Leguminosæ were called upon either to retreat to the tropics or adapt themselves to the new conditions. In this way large and important groups of xerophytes were developed simultaneously in the various extra-tropical regions, but in different morphological directions. Mr. Andrews is understood to have in hand an important work on the origin of the Australian flora as a whole.

Proportions of Land and Water in the Climatic Zones.—A consideration of some importance to anthropogeography is that of the relative extent of land and water in the different climatic zones, as bearing on the possibilities of economic development in the future. While the proportions have been worked out with care for the globe as a whole and (by Wagner and others) for zones of 10° (or even 1°) of latitude, such a calculation for the zones of climate has hitherto been wanting. The gap has now been filled by Prof. O. Marinelli, who gives the results of his measurements in the *Rivista Geografica Italiana* for July last. By making use of Wagner's calculations for 10° zones, it was sufficient merely to determine the areas of land and water, between 20° and 30° and between 60° and 70° on either side of the equator, which fall on one side or the other of the tropics and polar circles. The results are summarized in three tables, the first showing the areas within each of the continents falling to the different climatic zones, the second the proportion per cent. of each continent so falling, and the third the total land-area within each zone and its proportion to the total area of the zone. While 92 per cent. of Europe lies within the temperate zone, the corresponding figure for Asia is 76, for North America 77, and for Oceania 56. More significant still is the fact that while 51 per cent. of the total area of the north temperate zone is occupied by land, only 9 per cent. of the corresponding zone in the southern hemisphere is so occupied. Within the tropics 25 per cent. of the whole surface is land. Prof. Marinelli points out that the general importance of the south temperate zone from the point of view of human affairs is at present far less, in proportion to the north temperate, than the above ratio of 9 : 51. He calculates that as regards population the proportion between the two is as 2 to 51, and as regards economic conditions (external trade relations) as 4 : 51; the higher ratio in the latter case being due to the different conditions prevailing in new countries. Whether or not the adverse balance against the south will in course of time be redressed, at least in proportion to its more limited area, can hardly be foreseen.

GENERAL.

The Sea-Route to Siberia.—For the third year in succession Mr. Jonas Lied has carried out a successful trading voyage by the Kara Sea to the great Siberian rivers. He arrived at Grimsby on October 11 with the two steamers *Haugastoel* and *Eden*—chartered by him early in the summer on behalf of the Siberian Steamship Manufacturing and Trading Company—bringing valuable cargoes of Siberian produce (butter, hemp, flax, etc.) from the districts of the Obi and Yenisei. The venture this year was of special importance owing to the extent to which the Siberian railway is monopolized by the Russian Government for military purposes, and the large quantities of wheat, butter, linseed, hemp, and other produce which remain in Siberia awaiting the means of export. Mr. Lied hopes to repeat the voyage next year on a much larger scale, and thinks that the regular commercial use of the sea-route is now assured. The installation of wireless apparatus by the Russian Government at three stations on the borders of the Kara Sea has greatly helped to render the navigation of that sea feasible, as intelligence of the state of the ice can be conveyed by this means to approaching vessels, and the most suitable route pointed out. Thus during Mr. Lied's voyage, though ice was encountered west of the straits leading to the Kara Sea, the information received that the straits themselves were free enabled him to push on. Another satisfactory result of the voyage is the demonstration that the mouth of the Obi can be entered by vessels of considerable draught in spite of the shoals that partially obstruct it, so that cargoes can be taken on board direct from within this river as well as the Yenisei.

OBITUARY.

Sir John Laughton.

Sir John Knox Laughton, who died on September 14 last, was born at Liverpool on April 28, 1830, and when not at the university or on foreign service lived there till he was thirty years old. He was educated at the Royal Institution School at Liverpool and Gonville and Caius College, Cambridge, where he was placed among the Wranglers. He then proceeded to Germany where he studied for a time. At the outbreak of the Crimean War in 1854 Laughton, who always had a strong liking for the navy, applied for and received the appointment of naval instructor. He joined one of the ships afterwards belonging to the Baltic Fleet and at the close of the campaign received the war medal. He next served on the China station during the second Chinese war, taking part in the bloody boat action of Fat-Shan, the storming of Canton where he was amongst the first to mount the walls, and at the reduction of the Taku forts. For this campaign also he received a medal. Laughton next served in the Channel Fleet and then in the Mediterranean. I became his messmate in the early part of 1860 and we were together in the same ship for three years. He was a man of striking personal appearance, tall, of upright athletic figure, and handsome features.

When serving in the Mediterranean he was much interested in the geography of the Holy Land, on which he collected as extensive a library as the very modest dimensions of his cabin gave room for. Indeed his interest in geography was keen, and no doubt led him in 1869 to become a Fellow of the Royal Geographical Society, on the Council of which he served in 1880–83. He was then as he had been before and continued to be till the last greatly interested in history and especially in naval history. He was one of the earliest to understand what the composition of the British Empire really was and what sea-power meant in connection with it.

At the termination of his sea service he was appointed an instructor at the Royal Naval College at Portsmouth. One of the subjects which he had to teach the officers at the college was Maritime Meteorology. On this Laughton found that there was no suitable textbook. Accordingly, with the industry characteristic of him, he decided to compose one himself and in 1870 he published it as 'The Physical Geography of the Sea in its Relation to the Prevailing Winds and Currents.' The volume though intended to be used as a manual by naval students attracted attention outside their ranks. Sir Roderick Murchison wrote to the author to express his high opinion of the work, and as President of the Geographical Section of the British Association Meeting at Liverpool in 1870 warmly commended the book in his presidential address. At the meeting Laughton himself read a paper on the "Great Currents of the Atmosphere." Laughton, who was already a member of the Royal Astronomical Society, was one of the early members of the Royal Meteorological Society, and was its President from 1882 to 1884.

When the Naval College was removed to Greenwich Laughton—who also published a textbook on Nautical Surveying—was appointed an instructor and also lecturer in his favourite subject, Naval History.

After his final retirement from the active list of the Navy Laughton was appointed Professor of Modern History in King's College, London, a post which he held for many years. He was a frequent contributor to the *Edinburgh Review*, and most of the notices of eminent seamen in the 'Dictionary of National Biography' were written by him. That in other directions his pen was busy on

kindred subjects his published works are a proof. But what he probably regarded as the great work of his life was the foundation of the Navy Records Society in 1893. The first publication of this body appeared in 1894, being 'The State Papers relating to the Defeat of the Spanish Armada' edited by himself. Laughton was secretary of the society for more than twenty years, during which time he edited several other volumes. The labour involved in the discharge of his duties as he conceived them must have been enormous. He was freely consulted by inquirers from all parts of the world. Laughton was knighted by King Edward VII. in 1907, was made an honorary D.Litt. by the University of Oxford in 1904 and of Cambridge in 1913. He was also an honorary Fellow of his old college, Caius.

Sir John Laughton was twice married and had a large family. His eldest son Mr. Leonard Carr Laughton has for some time been known as a writer on naval subjects. His second wife Lady Laughton, who survives him, is the mother of three sons all of whom are serving their king and country—one in the navy and two in the army. If in the grave circumstances of to-day we have reason to congratulate ourselves on the strength and efficiency of our naval forces, we ought to remember that few men did more to teach our fellow-countrymen the importance of maintaining that strength and efficiency than the late Sir John Laughton.

CYPRIAN A. G. BRIDGE.

CORRESPONDENCE.

Denudation.

IN a recent issue of the *Geographical Journal* (vol. 45, 1915, p. 253) the conclusions of Keyes (*Science*, December 25, 1914, pp. 933-934) regarding the rate of denudation in the Mississippi Valley are quoted with approval.* Unless the article by Keyes is read in connection with the comments of Shaw (*Science*, February 12, 1915, pp. 244-245) an erroneous impression may be left on the minds of those unfamiliar with physiographic studies in the United States. The following points made by Shaw deserve attention. The stream measurements made by the United States Geological Survey and considered by Keyes to "go for naught" are widely recognized as well-nigh indispensable for engineering and geologic studies; they are not, however, being "undertaken with the express purpose of determining the rate of lowering of the continental surface." That the factors of crustal movement and wind deposition enter into the formula for continental denudation is too well known to require comment; but in what way does the recognition of these factors invalidate conclusions as to the measured amount of material transported by streams? The statement of Keyes quoted in your review: "wind-borne dusts from western deserts are alone probably depositing materials over the entire Mississippi Valley faster than the river and its tributaries are carrying rock waste to the sea," is not to be taken seriously. That the wind *could* do this is not doubted; that it has done or is now doing it is an assumption contrary to field evidence. With relatively unimportant exceptions the rocks exposed over the Mississippi drainage basin are water-laid or ice-laid, not wind-laid.

HERBERT E. GREGORY.

Yale University, July 20, 1915.

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* It appears to have been rather in the writer's mind to suggest that Mr. Keyes's views might require consideration than to express definite approval of them, though the opening sentence might certainly bear the latter construction. It will be seen that any approval hinted at was distinctly qualified in the closing remarks.—[Ed. *G.J.*]

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are as a rule written in full :—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendus.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Gen. = Genootschap.
Ges. = Gesellschaft.
I. = Institute, Institution.
Int. = International.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
Jber. = Jahresbericht.
k.(k.) = kaiserlich (und königlich).
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Austria. **Gayda.**

Modern Austria. Her racial and social problems. By Virginio Gayda. London: Fisher Unwin, 1915. Size 9 × 6, pp. 359. *Sketch-map. Price* 10*s.* 6*d. net. Presented.*

Balkans—Geography and Politics. **Newbigin.**

Geographical aspects of Balkans problems in their relation to the great European war. By Marion I. Newbigin. London: Constable & Co., 1915. Size 9 × 6, pp. viii. and 244. *Map. Price* 7*s.* 6*d. net. Presented.*

See review in the present number.

Denmark. **Harvey and Reppien.**

Denmark and the Danes. A survey of Danish life, institutions and culture. By William J. Harvey and Christian Reppien. London: F. Unwin, [1915]. Size 9 × 6, pp. viii. and 346. *Sketch-map and Illustrations. Price* 12*s.* 6*d. net. Presented.*

Europe—Political. **Hannah.**

Arms and the map. A study of nationalities and frontiers. By Ian C. Hannah. London: Fisher Unwin, [1915]. Size 7½ × 5, pp. viii. and 262. *Sketch-map. Price* 3*s.* 6*d. net. Presented.*

Italy—Natural limits. *La Geografia* **3** (1915): 162–168. **Magistris.**

Nil novi sub sole. Aspirazioni geografiche a rovescio dell' Austria sull' Italia. By Luigi Filippo de Magistris.

Calls attention to a discussion of Italy's natural limits, in contravention of Austrian claims, by Cesare Correnti in 1864.

Italy—Novara—Place-names. *La Geografia* **3** (1915): 192–201. **Sella.**

La grafia e la pronunzia dei nomi di comune e frazione di comune della provincia di Novara. By Attilio Sella.

Italy—Sardinia—Morphology. *Mem. G. N.* **28** (1915): 183–234. **Anfossi.**
Studi orometrici. II. Volumetria della Sardegna. By G. Anfossi. *Illustrations.*

Italy—Sardinia—Population. *La Geografia* **3** (1915): 179–192. **Anfossi.**
Densità e distribuzione altimetrica della popolazione in Sardegna. By Giovanni Anfossi. *Sketch-maps and Illustrations.*
See note in the Monthly Record, October, p. 313.

Italy—Valganna—Lakes. *Riv. G. Italiana* **22** (1915): 335–343. **Vanni.**
I laghi della Valganna. By Manfredo Vanni.

Norway—Bossekop—Magnetism. *Terrestrial Magnetism, etc.* **20** (1915): 1–12. **Störmer**
Preliminary Report on the Results of the Aurora-Polaris Expedition to Bossekop in the spring of 1913. By Carl Störmer. *Maps and Illustrations.*

Norway—Hydrology.
Vandstandiagttagelser i Norske Vasdrag 1913 utgit av Vasdragdirektøren. Christiania, 1914. Size 9½ × 6½, pp. 240. *Charts.* The same, 1914. Christiania, 1915. Size 9½ × 6½, pp. 246 and 22. *Charts.*

Norway—Precipitation. **Meteorological Institute.**
Nedbøriagttagelser i Norge. Utgit av det Norske Meteorologiske Institut. Aargang XX., 1914. [With supplement separate.] Kristiania: H. Aschehoug & Co., 1914. Size 14 × 11, pp. 65; (suppl.) 49. *Maps and Illustrations. Price Kr.* 3.00.

Rumania. *La G.* **30** (1915): 241–250. **Martonne.**
La Roumanie et son rôle dans l'Europe orientale. By Emm. de Martonne. *Sketch-map.*

Sweden—Hydrography.
Förteckning över Sveriges Vattenfall utgiven av Kungl. Vattenfallsstyrelsen och Hydrografiska Byrån. 9. Luleälv. 28 Uneälv. Stockholm, 1914. Size 17½ × 13½, pp. [12] and [33]. *Charts and Illustrations. Price* 50 *öre each.*

Sweden—Lappmark—Glaciation. *Ymer* (1915): 98–109. **Frödin.**
Några iakttagelser rörande glaciationen i norra delen af Lule Lappmark. Af John Frödin. *Illustrations.*

Turkey—Straits. *Popular Sc. Monthly* **87** (1915): 56–64. **Dominian.**
Eurasian waterways in Turkey. By Leon Dominian. *Also separate copy,* size 10 × 6½, pp. 8.
On the historical *rôle* of the Dardanelles and Bosporus.

United Kingdom—Cheshire—Salt. **Calvert.**
Salt in Cheshire. By Albert F. Calvert. London: F. Spon, 1915. Size 9 × 5½, pp. xxiv. and 1206. *Sketch-maps, Plans, Sections, and Illustrations. Price* 21*s. net. Presented.*
A well-nigh exhaustive history of the Cheshire salt industry.

United Kingdom—Glasgow district. **Gregory and others.**
P. Geologists' Ass. **26** (1915): 151–194.
The Geology of the Glasgow district. By J. W. Gregory, R. G. Carruthers, D. Ferguson, J. V. Harrison, Peter McNair, James Neilson, Alexander Scott, W. R. Smellie, James Stark, and G. W. Tyrrell. *Map and Illustrations.*

United Kingdom—Lake District. *P. Geologists' Ass.* **26** (1915): 195–223. **Green.**
The structure of the eastern part of the Lake District. By J. F. N. Green. *Illustrations.*

United Kingdom—Norfolk—Ecology. *J. Ecology* **3** (1915): 65–93. **Marsh.**
The Maritime ecology of Holme-next-the-sea, Norfolk. By A. S. Marsh. *Maps and Illustrations.*

United Kingdom—Text-book. **Claxton.**
An industrial geography of Britain. By William J. Claxton. London: Harrap & Co., 1915. Size 7½ × 5, pp. 144. *Sketch-maps, Diagrams, and Illustrations. Price* 9*d. Presented.*

Western war front. **Blanchard.**
Recueil Travaux I.G. Alpine (Grenoble) **3** (1915): 111–143.
Au long du front occidental. Par Raoul Blanchard.

ASIA.

Cambodia—Travel. *B.R.S.G.* (*Rome*), Ser. V. **4** (1915): 959-985. **Piscicelli.**
Nel Cambodge. By Maurizio Piscicelli. *Illustrations.*

China. *G.Z.* **21** (1915): 394–407. **Friederichsen.**
Süd-China nach Ferd. von Richthofen. Von Max Friederichsen.

China—Yunnan—Sheep. *B. Economique Indochine*, N.S. **18** (1915): 165–181. **Hallot.**
La race ovine du Yunnan. By A. Hallot.

Turkey—Historical. *Rendiconti R.A. Lincei*, Ser. V., **23** (1915): 293–315. **Benini.**
Il grande Sion, il Sinai e il piccolo Sion. (Dove ha posto Dante l'entrata dell' inferno.) By R. Benini. *Illustrations.*

Turkey—Palestine—Archæology. **Woolley and Lawrence.**
The wilderness of Zin (Archæological report). By C. Leonard Woolley and T. E. Lawrence. (Palestine Exploration Fund, Annual, 1914–1915.) London, [1915]. Size 11½ × 8½, pp. xvi. and 151. *Plans and Illustrations.*
See review in the July number, p. 55.

Turkey—Syria—Map. *Missions Catholiques* **47** (1915): 384. ——
Notre prime. Carte de la Syrie (partie septentrionale), à l'échelle du 1 : 400,000. *Map.*
A clearly drawn map based on the best authorities.

AFRICA.

Egypt—Nubia. **Survey Department.**
Egypt. Survey Department. The Archæological Survey of Nubia. Report for 1909–10. By C. M. Firth. Cairo, 1915. Size 14½ × 10½, pp. viii. and 180. *Plans, Illustrations and Sections. Presented.*

Morocco. **Bernard.**
Le Maroc. Par Augustin Bernard. 3rd edition. Paris, 1915. Size 9 × 5½, pp. viii. and 420. *Sketch-maps. Price 5 francs.*
This important work has been revised and brought up to date (see review of the first edition in vol. **42**, p. 561).

South-West Africa. *B. Imperial I.* **13** (1915): 233–460. ——
The economic resources of the German colonies. II. German South-West Africa. *Sketch-map.*

Sudan. **Tilho.**
République française: Ministère des Colonies. Documents scientifiques de la Mission Tilho (1906–1909). Tome III. Paris: Émile Larose, 1914. Size 11 × 7, pp. viii. and 484. *Map, Illustrations, and Diagrams. Presented.*
Deals with anthropology, zoology, and botany.

Tripoli—Bibliography. **Ceccherini.**
Ministero delle Colonie. Bibliografia della Libia (in continuazione alla "Bibliografia della Libia" di F. Minutilli). Compilata da Ugo Ceccherini. Rome, 1915. Size 9½ × 7, pp. 204.

West Africa—Niger. *La G.* **30** (1915): 251–256. **Gironcourt.**
La descente du bas Niger dans la zone des rapides. By G. de Gironcourt. *Sketch-map and Illustrations.*
See note in the September number, p. 240.

West and Central Africa—Temperature. *C.R.A. Sc.* **161** (1915): 106-109. **Chudeau.**
La température en Afrique occidentale et équatoriale. By R. Chudeau.
Noticed in the Monthly Record, *supra.*

NORTH AMERICA.

Alaska—Earthquake. *B.S. Languedocienne G.* **38** (1915): 194–203. **Moye.**
Le tremblement de terre de l'Alaska de 11 Septembre, 1899. Par M. Moye.

Alaska—Geology. *U.S. Geol. Surv., Profess. Paper* **87** (1915): pp. 110. **Wright.**
Geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska. By Charles Will Wright. *Maps and Illustrations.*

Atlantic Coast—Fisheries. **Alexander and others.**

Department of Commerce. Bureau of Fisheries. Otter-Trawl fishery. By A. B. Alexander, H. F. Moore, and W. C. Kendall. Appendix VI. to the report of the U.S. Commissioner of Fisheries for 1914. Washington, 1915. Size 9 × 6, pp. 97. *Map and Illustrations.*

Canada—British Columbia. **Longstaff**

The history and topography of Okanagan. For the active militia in camp. May, 1914. By Captain F. V. Longstaff. Pp. 10. [Type-written.]

Canada—British Columbia—Coal. **Dowling.**

Canada, Geol. Surv., Mem. **69** (1915): pp. iii., 30 and vii.

Coalfields of British Columbia. Compiled by D. B. Dowling. *Maps.*

Canada—Quebec. *Canada, Geol. Surv., Mem.* **64** (1915): pp. xii., 280 and vi. **Keele**

Preliminary Report on the clay and shale deposits of the province of Quebec. By J. Keele. *Map and Illustrations.*

Canada—Quebec—Ungava. ——

Extracts from reports on the district of Ungava recently added to the province of Quebec under the name of the Territory of New Quebec. Quebec, 1915. *Map and Illustrations.*

Canada—Rockies. *Appalachia* **13** (1915): 238–257. **Fay.**

The Canadian Rockies between the Yellowhead Pass and the Peace River. By S. Prescott Fay. *Sketch-map and Illustrations.*

Canada—Rockies. *Canadian Alpine J.* **6** (1914 and 1915): 170–177. **Fay.**

"Mount Alexander." By S. Prescott Fay. *Map and Illustrations.*

Canada—Rockies. *Canadian Alpine J.* **6** (1914 and 1915): 188–200. **Jobe.**

The Expedition to "Mount Kitchi." By Mary L. Jobe. *Illustrations.*

The above three papers describe the expeditions to the region north of Mount Robson referred to in the September number, p. 242.

Canada—Rockies—Glaciers. **Wheeler.**

Canadian Alpine J. **6** (1914 and 1915): 133–138, 139–142.

Motion of the Yoho Glacier (1912–1914). By Arthur O. Wheeler. *Illustration.*

Robson Glacier. By the same. *Illustrations.*

Canada—Rockies—Mount Robson. **Kain.**

Canadian Alpine J. **6** (1914 and 1915): 19–28.

The first ascent of Mount Robson (1913). By Conrad Kain. *Illustrations.*

Canada—Rockies—Place-names. **White.**

Canadian Alpine J. **6** (1914 and 1915): 143–158.

Place-names in the vicinity of Yellowhead Pass. By James White.

North America—Indians. *Appalachia* **13** (1915): 257–271. **Bent.**

The Indians and the Mountains. By Allen H. Bent.

On the Indians' feeling for mountains, and legends connected therewith.

United States—California. *Popular Sc. Monthly* **87** (1915): 22–30. **Abrams.**

The Floral Features of California. By Dr. Le Roy Abrams. *Illustrations.*

United States—Climate. **Weather Bureau.**

Climatological Data for the United States by Sections. Vol. **1** (13 parts), January to September, 1914. (U.S. Department of Agriculture, Weather Bureau.) Washington, 1914. Size 12 × 8½. [Each section paged separately.] *Maps.*

United States—Cotton. *Dept. Commerce, Bureau Census, B.* 128 (1914): pp. 30. ——

Supply and Distribution of Cotton for the year ending August 31, 1914. *Sketch-map and Diagrams.*

United States—Dry-farming. **Briggs.**

Rept. British Ass. Adv. Sc., Australia 1914 (1915): 263–282.

Dry-Farming Investigations in the United States. By Lyman J. Briggs. *Illustrations.*

United States—Maine—Mount Ktaadn. *Appalachia* **13** (1915): 227–238. **Sayward.**

A winter ascent of Mount Ktaadn. By Perceval Sayward. *Sketch-map and Illustrations.*

United States—Philadelphia. *B.G.S. Philadelphia* **13** (1915): 91–109. **Keir.**
The causes for the growth of Philadelphia as an industrial center. By R. Malcoln Keir. *Sketch-map and Illustrations.*

CENTRAL AND SOUTH AMERICA.

Argentine—Buenos Aires. **Roth and others.**
An. Museo Nacional Buenos Aires **26** (1915): 417–431.
Nuevas investigaciones geológicas y antropológicas en el litoral marítimo sur de la provincia de Buenos Aires. By Santiago Roth, and others. *Illustrations.*

Brazil—Amazonas. **Whiffen.**
The North-West Amazons. Notes of some months spent among Cannibal tribes. By Capt. Thomas Whiffen. London: Constable & Co., 1915. Size 9 × 6, pp. xviii. and 320. *Maps and Illustrations. Price* 12*s.* 6*d. net. Presented.*

Brazil—Matto-Grosso. ———
Album Graphico do Estado de Matto-Grosso. (E. E. U. U. do Brazil.) (Rio de Janeiro, 1915.) Size 12 × 15½, pp. 434 and lxx. *Maps and Illustrations. Presented.*
A profusely illustrated general account of the state and its present-day activities.

Brazil—Rio Grande. **Beverini.**
Ministero degli Affari Esteri. Anno 1915. No. 11. Il porto e la barra di Rio Grande e la loro importanza commerciale. By Giovanni Battista Beverini. Rome, 1915. Size 9 × 6, pp. 8. *Price L.*0.15.

Brazil—Rio da Duvida. *B.S.G. Lisboa*, 1915 (1915): 97–107. **Vasconcellos.**
A proposito do rio da Duvida. Por Ernesto de Vasconcellos.
The writer maintains that the river explored by the Roosevelt-Rondon Expedition was shown in some early Portuguese maps.

British Guiana—Economic. *B. Imperial I.* **13** (1915): 203–233. **Harrison.**
The field and forest resources of British Guiana. By J. B. Harrison.

Panama Canal. *B.R.S.G. (Rome)*, Ser. V., **4** (1915): 821–856. **Jaja.**
Il canale di Panama. By Goffredo Jaja.

South America—Meteorology. *Q.J.R. Meteor. S.* **41** (1915): 201–208. **Clayton.**
A study of the moving waves of weather in South America. By H. H. Clayton. *Maps.*

Uruguay—Statistics. ———
La République Orientale de l'Uruguay. Quelques renseignements statistiques. Montévideo, 1915. Size 10 × 6½, pp. 68. *Map. Presented.*

AUSTRALASIA AND PACIFIC ISLANDS.

Australia—Artesian water. ———
Report of the second inter-State conference on Artesian water. Brisbane, 1914. Size 13 × 8, pp. xx. and 295. *Maps and Illustrations.*
See article in the present number.

Australia—Northern Territory. **Cummins.**
Queensland G.J. **28–29** (1912–1914): 65–79.
The Daly River—Northern Territory. By J. J. Cummins.

Australia—Northern Territory. **Masson.**
An untamed territory. The Northern territory of Australia. By Elsie R. Masson. London: Macmillan & Co., 1915. Size 8 × 5½, pp. x. and 182. *Sketch-maps and Illustrations. Price* 6*s. Presented.*

Central Australia. *Victorian G.J.* **31** (1915): 4–20. **Macdonald.**
Central Australia—its possibilities. By A. C. Macdonald. *Map and Illustrations.*

Central Australia. **White and others.**
T. and P.R.S. South Australia **38** (1914): 407–484.
Scientific notes on an expedition into the interior of Australia, carried out by Captain S. A. White, M.B.O.U., from July to October, 1913. By S. A. White and others. *Map and Illustrations.*

New Guinea—Name. **L'H.N. and Wieder.**

Ts. K. Nederl. Aardr. Gen. 2 Ser., **32** (1915): 527–533, 533–534.

Nueva Guinea, *Nova* Guinea, Nieuw-Guinea, Nieuw-Guinee. By L'H. N. Wanneer en hoe werd de naam van Nieuw-Guinea het eerst gedrukt? By F. C. Wieder.

See note in the Monthly Record, *supra*, p. 398.

POLAR REGIONS.

Antarctic—Shackleton Expedition. **David and others.**

British Antarctic Expedition, 1907–9, under the command of Sir E. H. Shackleton. Reports on the scientific investigations. Geology. Vol. 1. Glaciology, physiography, stratigraphy, and tectonic geology of South Victoria Land. By Prof. T. W. E. David and Raymond E. Priestley. With short notes on Palæontology by T. Griffith Taylor and Prof. E. J. Goddard. London: Wm. Heinemann, 1914. Size 12 × 10, pp. xxiv. and 318. *Maps, Illustrations, and Sections. Presented.*

Greenland—Danish expedition. **Koch and Wegener.**

Z. Ges. E. Berlin (1914): 34–50, 50–54.

Unsere Durchquerung Grönlands, 1912–1913. Von J. P. Koch. *Sketch-maps.* Vorläufiger Bericht über die wissenschaftlichen Ergebnisse der Expedition. Von Dr. Alfred Wegener.

MATHEMATICAL GEOGRAPHY.

Cartography—Scales. *Z. Ges. E. Berlin* 1914: 1–33. **Wagner.**

Der Kartenmasstab. Von Dr. Hermann Wagner.

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Geology—Essays. **Glasgow University.**

Papers from the Geological Department, Glasgow University. Vol. 1. 1914. Glasgow: James Maclehose & Sons, 1915. Size 9½ × 6. [Each paper paged separately.] *Maps and Illustrations. Presented.*

A collection of reprints of papers by members of the Geological Department.

Geomorphology. *Victorian G.J.* **31** (1915): 23–43. **Le Souef.**

Coastal erosion. By W. H. D. Le Souef. *Illustrations.*

Geomorphology—Land and water. *Riv. G. Italiana* **22** (1915): 356–361. **Marinelli.**

La proporzione fra terre ed acque nelle diverse zone terrestri. By Olinto Marinelli.

A calculation by zones, based on Wagner's by ten-degree intervals, but with the necessary subsidiary measurements (see note, *supra*, p. 400).

Geophysics. *C.R.A. Sc.* (*Paris*), **161** (1915): 139–141. **Belot.**

Le déficit et l'excès de la pesanteur sur les continents et les îles en rapport avec la condition isostatique de la croûte terrestre. By Emile Belot.

A mathematical discussion.

Geophysics. **Joly.**

The Birth-time of the World and other scientific essays. By Dr. J. Joly. London: Fisher Unwin, [1915]. Size 9 × 6, pp. xv. and 306. *Illustrations and Sections. Price* 10*s.* 6*d. net. Presented.*

Geophysics. *C.R. A. Sc.* (*Paris*), **160** (1915): 787–794. **Boussinesq.**

Extrême lenteur du refroidissement dans les parties profondes de la croûte terrestre et tentative pour y apprécier, à partir d'une certaine époque, les progrès de la solidification. By J. Boussinesq.

Geophysics. *Rept. British Ass. Adv. Sc.*, Australia, 1914 (1915): 344–358. **Holland.**

[On theoretical conceptions regarding the interior of the Earth.] By Sir T. H Holland.

The President's address to Section C

Geophysics. *Mem. R. Astronomical S.* **60** (1915): 187-226. **Jeffreys.**
Certain hypotheses as to the internal structure of the Earth and Moon. By Harold Jeffreys.

Geophysics—Latitude variation. **Tydeman.**
Ts. K. Nederl. Aardr. Gen., 2 Ser. **32** (1915): 449-456.
De "pendulatie-theorie" en de breedtverandering. Door G. F. Tydeman.

Glaciation. *P.A. Nat. Sc. Philadelphia* **67** (1915): 2-24. **Meunier.**
Observations sur la théorie générale des phenoménes glaciaires et sur les galets striés. Par Stanislas Meunier.

Meteorology—Circulation. **Sandström.**
Arkiv Mathematik, Astronomi och Fysik **9** (1914): No. 31, pp. 8.
Ueber die Ablenkung des Windes infolge der Erddrehung und der Reibung. Von J. W. Sandström. *Sketch-map and Illustrations.*

Oceanography—Horse Latitudes. **Sandström.**
Arkiv Mathematik, Astronomi och Fysik **9** (1914): No. 32, pp. 5.
Ueber die Anhäufung des warmen Meerwassers in den Rossbreiten. Von J. W. Sandström. *Illustrations.*

Physiography—Arid lands. **Holland.**
Rept. British Ass. Adv. Sc., Australia, 1914 (1915): 363-371.
Discussion on the physiography of arid lands. By Sir T. H. Holland and others.

Seismology. *Riv. G. Italiana* **22** (1915): 321-334. **Loperfido.**
Le cause sismiche. By A. Loperfido.

Solar radiation. **Abbot, Fowle, and Aldrich.**
Smithsonian Miscellaneous Collections **65** (1915): No. 4, pp. 55.
Hodgkin's Fund. New evidence on the intensity of solar radiation outside the atmosphere. By C. G. Abbot, F. E. Fowle, and L. B. Aldrich. *Illustrations.*

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Anthropology—Mummies. **Smith.**
Mem. and P. Manchester Lit. and Phil. S. **59** (1915): No. 10, pp. 143.
On the significance of the geographical distribution of the practice of mummification. A study of the migrations of peoples and the spread of certain customs and beliefs. By Professor G. Elliot Smith. *Map.*

Historical—Tin trade. **Blázquez y Delgado-Aguilera.**
B.R.S.G. (Madrid) **56** (1915): 318-368.
Las Casiterides y el comercio del estaño en la antigüedad. Por Antonio Blazquez y Delgado-Aguilera.

History of Cartography. *B.R.S.G.* **56** (1915): 369-374. **Blázquez.**
Noticia de un Atlas del siglo XVI. manuscrito y desconocido. Por Antonio Blázquez. *Facsimile.*
An atlas, dated 1590, by Bertholomeu Laso, about whom nothing seems to be known.

History of Navigation. **Bensaude and others.**
Histoire de la science nautique Portugaise à l'époque des grandes découvertes. Collection de Documents publiés . . . par Joaquim Bensaude. Vol. **1.** Regimento do Estrolabio e do Quadrante. Tractado da spera do Mundo. Munich: Carl Kuhn, 1914. Size 11 × 7½, pp. 64. *Facsimiles. Presented.*
The same. Vol. **3.** Almanach perpetuum celestium motuum (Radix 1473). Tabulæ astronomicæ Raby Abraham Zacuti. In latinum translatæ per Magistrum Joseph Vizinum. Munich: J. B. Obernetter, 1915. Size 10½ × 8, pp. 336. *Facsimiles. Presented.*
The same. Vol. **4.** Tratado del Esphera y del arte del marear. Compuesto por Francisco Faleiro. Munich: J. B. Obernetter, 1915. Size 10 × 7½, pp. 102. *Facsimiles. Presented.*
The same. Vol. **5.** Tratado da Sphe.a . . . Pello Dr. Pero Nunez. Munich: J. B. Obernetter, 1915. Size 15 × 10, pp. 180. *Facsimiles. Presented.*

This valuable series of facsimile editions of rare old works was referred to by Sir Clements Markham in his article published in the September number. A sixth reproduction—of the "Reportorio" of Valentine Fernandes—is to follow, as well as a volume containing Senhor Bensaude's series of introductions.

BIOGRAPHY.

Herbertson. *Scottish. G. Mag.* **31** (1915): 486–490. **Cossar.**

Obituary: A. J. Herbertson, Professor of Geography in the University of Oxford. By J. Cossar.

Kitchener. **Daiches.**

Lord Kitchener and his work in Palestine. By Dr. Samuel Daiches. London: Luzac & Co., 1915. Size 7½ × 5, pp. 88. *Price 2s. 6d. net. Presented.*

Murray. *P.R.S.*, Ser. A., **91** (1915): liv.-lxii. **A. E. S.**

Sir John Murray, K.C.B. By A. E. S.

GENERAL.

Education—Text-books. **Franklin and Shearmur.**

The Atlas Geographies. Preparatory: Earth lore (pp. 40). The world and its peoples (pp. 44). By Thomas Franklin and E. R. Shearmur. London: W. & A. K. Johnston, [1915]. Size 10 × 7½. *Maps, Diagrams, Illustrations, and Sections. Price 7d. net each. Presented.*

Education—Text-books. **Franklin and Shearmur.**

Practical Geography Note-books. Based upon the Atlas Geographies. By Thomas Franklin and Ernest R. Shearmur. Asia. London: W. & A. K. Johnston, 1915. Size 10 × 7½, pp. 40. *Sketch-maps. Price 4d. net. Presented.*

NEW MAPS.

By E. A. REEVES, Map-Curator, R.G.S.

EUROPE.

Europe. **Johnston.**

War Map of Europe, 1914–1915, showing all the War Areas. Scale 1 : 4,800,000 or 1 inch to 76 stat. miles. Size 27 by 37 inches. Edinburgh and London: W. & A. K. Johnston, Ltd., 1915. *Price, unmounted, 6d. Presented by the Publishers.*

A cheap map showing the greater part of Europe south of Lake Ladoga and the Gulf of Finland. The physical features as laid down are out of date, but the international boundaries and railways have been revised.

Turkey. **Geographical Section, General Staff.**

Map of the Peninsula of Gallipoli and the Asiatic Shore of the Dardanelles. Scale 1 : 63,360 or 1 inch to 1 stat. mile. 2 sheets each 21 by 30 inches. Geographical Section, General Staff, War Office, 1915. London agents: E. Stanford, Ltd.; Sifton, Praed & Co.; T. Fisher Unwin. *Price 1s. 6d. each sheet. Presented by the Director of Military Operations.*

This map will be most useful at the present time, as it is on sufficiently large scale to show considerable detail. The physical features are well represented. Relief is shown by approximate contour lines in brown at 100 feet vertical intervals, wooded land in green, and water blue. It has been compiled from the latest surveys and reconnaissances of officers, combined with earlier information.

ASIA.

India. **Surveyor-General of India.**

Maps published by the Survey of India during the quarter ending June 30, 1915. —**Miscellaneous Maps**: Conventional signs. New characteristic sheet of symbols (larger Table), ditto (small Plate); scale 3 inches to 1 mile, Mercara Hunt map. **District Maps**: scale 1 inch to 4 miles, Burdwan; Nowgong. **India and adjacent countries**: scale 1 : 1,000,000, sheet 92 (2nd provisional issue). **Degree sheets**, scale 1 inch to 4 miles, 43 C, Punjab and North-West Frontier Province, 54 J (provisional issue), Rajputana, Central India and United Provinces, 55 C (provisional issue), Bombay, Berar, Central India and Central Provinces, 63 D (provisional issue), Central India, United Provinces and Central Provinces, 63 F (provisional issue), United Provinces, 65 O (provisional issue), Madras, 74 A (provisional issue), Madras, Bihar, and Orissa, 85 M (provisional issue), Burma. **Standard Maps**: scale 1 inch to 1 mile, 43 F-6, 43 O-2, Kashmir and Jammu;

44 I–13, 44 I–15, 44 I–16, 44 M–6, 53 B–5, 53 B–14, Punjab; 55 G–9 and 13 (26). Central Provinces: 57 G–12, Mysore; 57 H–8, Madras and Mysore; 57 H–15, Madras; 62 D–14, United Provinces and Nepal; 63 A–6, 63 A–8, 63 A–9, 63 A–15, 63 A–16, 63 E–3, 63 E–4, 63 E–7, 63 E–8, 63 E–12, 63 E–16, 63 F–1, 63 F–2, 63 F–3, 63 F–5, 63 F–6, 63 F–9, 63 F–10, 63 F–11, United Provinces; 72 C–3, 73 A–8, 73 A–11, 73 A–16, 73 E–1, 73 J–7 (preliminary edition with village boundaries), Bihar and Orissa; 79 A–12 and 16 (308), Bengal; 92 G–9, 92 G–10, 94 C–1 and 5 (259, 2nd edit.), Burma. Calcutta: Map Record and Issue Office, 1915. *Presented by the Surveyor-General of India.*

AMERICA.

Canada. **Dept. of Mines, Ottawa.**

Geological Survey of Canada. Map 122 A, Upper White River District, Yukon Territory. Scale 1: 250,000 or 1 inch to 3·9 stat. miles. Size 15 by 7 inches. Maps 140 A and 141 A, Yukon-Alaska International Boundary between Yukon and Porcupine Rivers. Scale 1: 125,000 or 1 inch to 1·9 stat. miles. Size of each sheet 28 by 11 inches. Map 143 A, Shuswap Lake, Kamloops District, British Columbia. Scale 1: 253,440 or 1 inch to 4 miles. Size 13 by 21 inches. Ottawa: Department of Mines, 1915. *Presented by the Department of Mines, Geological Survey, Ottawa.*

Map 122 A.—Includes the course of the White River from Cache Creek above Canyon City to Beaver Creek and the country to the west. Contours are in brown at intervals of 500 feet, those not well defined being shown in dotted lines. Water is in blue.

Maps 140 A and 141 A.—The boundary between Canada and Alaska from Mount St. Elias to the Arctic Ocean runs due north and south along the 141st meridian, and the section of it shown on this map extends for a distance of about 190 miles. The country on either side of the line for between 2 and 3 miles has been surveyed in considerable detail, and contours are given at intervals of 100 feet. Upon this excellent basis the geological features are represented by colour tinting from the work of Mr. D. D. Cairnes in 1911–12. The map is in two sheets, and is accompanied by geological sections. A map with a description of the continuation of this survey from the Porcupine river to the Arctic Ocean was given by Mr. Nellas in the *Geographical Journal* for January, 1913. The present map is to accompany the memoir of Mr. D. D. Cairnes.

Map 143 A.—The topographical basis of this map is the Shuswap sheet, No. 604 of the Geological Survey of Canada, 1898. Contours are given at 250 feet intervals. The geological colouring, which is from the work of Mr. R. A. Daly in 1911–12, only covers a part of the area included, being confined to the immediate neighbourhood of the lakes and the principal river valleys.

Canada. **Dept. of the Interior, Ottawa.**

Map showing branches of Chartered Banks in Ontario and Quebec. Prepared in the Railway Lands Branch under the direction of F. C. C. Lynch, superintendent. 2nd edition. Scale 1: 1,584,000 or 1 inch to 25 stat. miles. Size 20 by 32 inches. Ottawa: Department of the Interior, 1915. *Presented by the Department of the Interior, Ottawa.*

An outline map showing railways and the different railway systems in colours, with the names of the places where there are branches of the Chartered Banks in the same colour as the railway.

Canada. **Dept. of the Interior, Ottawa.**

Sectional Map of Canada. Scale 1: 190,080 or 1 inch to 3 stat. miles. Sheets: 124, Oiseau, Manitoba and Ontario, 1st edit., March 1, 1915; 221, Swan River, Manitoba, 5th edit., September 1, 1914; 265, Peace Hills, Alberta, 9th edit., December 1, 1914. Size 17 by 29 inches. Ottawa: Department of the Interior, 1915. *Presented by the Department of the Interior, Ottawa.*

United States. **U.S. Geological Survey.**

Carte Internationale du monde au Millionième (1 inch to 15·78 stat. miles). Sheet North J 10. San Francisco Bay. Compiled, engraved and published by the United States Geological Survey, George Otis, Director. Washington, December, 1914. *Presented by the Director of the U.S. Geological Survey.*

The area included in this sheet extends from 36° to 40° N. lat. and from 120° to 126° E. long. San Francisco Bay comes roughly in the centre, and about one half of the sheet represents land, extending from 130 to 190 miles from San Francisco while the other half is occupied by the adjacent Pacific Ocean. The land relief is shown by the combined contour and colour layer system in general accordance with

the arrangement for the production of this map, except as regards the higher altitudes, where a somewhat unsatisfactory pink is used for altitudes between 1000 and 2000. On the land the contour interval is 100 metres, with the addition of the 50 metres contour in the lowland, while the colour tints change only at the 200, 500, 1000 and 2000 metres contours. For the depths of water the contours are at 100 metres with the 50 metre line added, and the deepening shades of blue change at 200, 500, 1000, and 3000 metres. The system adopted serves well to bring out the relief of this interesting area, and the Sacramento and San Joaquim valley with surrounding ranges are well shown. The general execution is very creditable, and the sheet is a decided improvement on the Boston sheet previously published by the same department.

United States. **U.S. Geological Survey.**

Topographical maps of the United States issued March 1, 1914—April 30, 1915. Scale 1:250,000 (1 inch to 3·9 stat. miles), sheets: Alamo National Forest, N. Mex.; Chitina, Alaska. Scale 1:125,000 (1 inch to 1·9 stat. miles), sheets: Caliente, Cal.; Cheyenne, Wyo.; Cholame, Cal.; *Glacier National Park, Mont.; Hereford, Ariz.; Lost Hills, Cal.; Mount Morrison, Cal.—Nev.; *Murphy, Tenn.—N.C.; *Nowata, Okla.; Nyack, Mont.; Pine, Oreg.—Idaho. Scale 1:62,500 (1 inch to 1 mile), sheets: Ames, Iowa; Axial, Colo.; Baldwin, Ill.; Battle Lake, Minn.; Bethel, Me.; Big Bend, W. Va.; Boring, Oreg.; Brockton, Mont.; Bryan, Ohio; Bryant Pond, Me.; Capitola, Cal.; Celina, Ohio; Centralia, Ill.; Chester, Ill.—Mo.; Churubusco, N.Y.; *Cincinnati, Ohio—Ky.; Circleville, Ohio; Corning, N.Y.; Crawford, W. Va.; Crystal City, Mo.—Ill.; Cuskers, Mont.; Daingerfield, Tex.; Deerwood, Minn.; Douglas, Ariz.; Dunmor, Ky.; *East Cincinnati, Ohio—Ky.; Eccles, W. Va.; Flattop, W. Va.; Fredericktown, Ohio; Gambier, Ohio; Gay Hill, Tex.; Gillespie, Ill.; Grand Rapids, Mich.; Green City, Mo.; Hanna, Wyo.; Homestead, Mont.; Houghton, Mich.; Iuka, Miss.—Ala.—Tenn.; Lanes Creek, Idaho; Little Muddy, Ky.; Loudonville, Ohio; Macomb, Ill.; Madrid, Iowa; Malaga, Wash.; Meadow Creek, W. Va.; Meeker, Colo.; Mesa, Ariz.; Milton, Vt.; Monticello, Ky.; Monument Butte, Colo.; Navarre, Ohio; Nemaha, Nebr.—Mo.; Number Four, N.Y.; Oregon City, Oreg.; Orland, Cal.; Paulding, Ohio; Perrysville, Ohio; Petaluma, Cal.; Phœnix, Ariz.; Pioneer, Ohio—Mich.; Platte County, Mo.; Port Valdez District, Alaska; Pound, Va.—Ky.; Raton, N. Mex.; Renault, Ill.—Mo.; Roxabell, Ohio; Sago, W. Va.; Scale, Ala.—Ga.; Smithville, Mo.; Spring Creek, Mont.; Sunnyside, Utah; Swanton, Ohio—Mich.; Todd Lake, Mont.; Troy, Ohio; Tule Valley, Mont.; Underwood, Minn.; Van Wert, Ohio; Vergas, Minn.; Walcott, Wyo.; *West Cincinnati, Ohio—Ky. Scale 1:31,680 (2 inches to 1 stat. mile), sheets: Avena, Cal.; Baxter Bayou, La.; Brentwood, Cal.; Burnham, Cal.; Hamilton, Cal.; Kirkwood, Cal.; Lathrop, Cal.; McIntosh Landing, Cal.; Manteca, Cal.; Peters, Cal.; Union Island, Cal.; Vernalis, Cal.; Walker Creek, Cal. Scale 1:31,250 (2·03 inches to 1 stat. mile), sheet: Mesa Verde National Park, Colo. Washington: Department of the Interior, U.S. Geological Survey, 1914–15. *Presented by the Director of the U.S. Geological Survey.*

All these sheets are new except those marked with an asterisk, which are revised editions.

PHOTOGRAPHS.

Mexico. **Harkness.**

Twelve photographs of Mexico, taken by W. Young Harkness, 1915. *Presented by W. Young Harkness, Esq.*

These photographs give a good idea of conditions of life in Mexico at the present day. They measure about 3¼ × 5½ inches.

(1) Travelling facilities in outlying districts; (2 and 3) A native rancho; (4) Bringing in firewood; (5) Two Zapatista generals; (6) A colonel of the famous Rurales. (7) One of the Rurales with his better half; (8) Undisciplined but brave to a fault; (9) Four Zapatista prisoners five minutes before being shot; (10 and 11) Two Zapatista prisoners after the fight; (12) Three prisoners being taken to the cemetery to be shot.

N.B.—It would greatly add to the value of the collection of Photographs which have been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.